

SHELLS AND OTHER ANIMAL REMAINS FOUND
ON THE MADRAS BEACH

II.—SNAILS, ETC. (MOLLUSCA GASTROPODA)

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The scope and some of the limitations of this paper have already been explained in the introduction to Part I, so need not be repeated here. And as my indebtedness to others, particularly to Mr. Winckworth and Mr. Crichton, has been fully acknowledged there I need only record now that it is as great for this part as it was for that.

In Gastropods the shell is single or *univalve* and is as a rule spirally coiled, forming a protective retreat into which the animal can withdraw itself at will. The inner side of the spiral forms an axis or *columella* which is usually solid. When the columella is hollow the cavity round which it is coiled opens to the exterior at the base of the shell, and even when it is more or less completely solid this opening, which is known as the *umbilicus*, often remains. Sometimes the surface of the columella is thickened by a *callus* which may extend over the neighbouring surface.

The last formed (lowest) *whorl* or complete single twist of the shell is called the *body whorl*, the remaining whorls together forming the *spire*. The line along which adjoining whorls are united is called the *suture*. At the apex of the spire the embryonic shell or *protoconch* can often be distinguished. Though apt to differ in appearance and sculpture from the remaining coils of the shell, it usually forms an unbroken continuation of them. When this is not so the shell is said to be *heterostrophic*. The mouth of the shell is known as the *aperture*. When (as is usual) the shell has a right-handed or *dextral* coil the aperture is to the (observer's) right of the columella, but in *sinistral* (left-handed) shells it is on the left. The aperture necessarily faces the foot when the animal is active and is therefore ventral, its lower part (which forms the base of the shell) being anterior and its upper part posterior. The *lips* forming the margin of the aperture may be entire, or the *outer lip* may be divided from the *columella lip* by an *anterior canal* at the base of the columella, and sometimes also by a *posterior canal* at the opposite end. Some kinds of shell are characterised by the presence of more or less thick and definite ridges or *varices* (sing. *varix*) crossing the whorls and marking the limits of periods of active growth. The aperture can often be closed by a sort of door or *operculum* attached to the foot. This operculum may be either horny (*chitinous*) or stony (*calcareous*).

Sculpture is usually more or less definitely longitudinal or transverse or both. But such terms are apt to be ambiguous, for whatever is longitudinal to the spire is transverse to the whorls of the spiral. To avoid this ambiguity the terms *spiral* and *transpiral* are therefore used below in place of them, except when reference is to the shell as a whole and not to its whorls.

The arrangement and nature of the teeth on the *radula*, the ribbon of teeth with which the snail takes its food, afford valuable characters for purposes of classification and have been extensively used by recent specialists¹

Gastropods are divided into a very large number of families. But many contain rare or small and inconspicuous species only, or species with only small or fragile internal shells, or with no shells at all, while others are found only on land or in fresh water. The number of families represented by shells likely to be found on the Madras Beach is therefore much less, and only these families and a few others, examples of which live in the backwaters or in and about the harbour, are dealt with below².

The most complete and up-to-date classification of the Mollusca is at present that of Thiele's "Handbuch der systematischen Weichtierkunde" (Jena, 1931). In some points (e.g., the position of the limpets) this improves on Pelseener's classification in his volume on Mollusca in "Lankester's Treatise on Zoology" which in general it follows, a volume which still remains the standard account of the group in English. Pelseener's system has in the main been followed below, but has been modified wherever this seemed necessary in the light of Thiele's more recent work.

Gastropods are divided by Pelseener into two subclasses, *Streptoneura* (= *Prosobranchia* Thiele) in which the nerve trunks to the digestive organs are twisted into a figure-of-eight, the head has a single pair of tentacles, and each individual of almost all species is male or female only; and *Euthyneura* in which this twist of the nerve trunks (and certain other organs) is straightened out in the adult, and all species are hermaphrodite. The vast majority of Gastropod sea shells belong to the former subclass, but most soft-bodied marine Gastropods belong to the *Opisthobranchia* section of the *Euthyneura*, comprising marine forms with aquatic respiration, while most land and fresh-water shells belong to the other section of the same subclass, the lung-breathing *Pulmonata*, a few of which have reverted to marine life.

But this classification, important though it is as a guide to true and natural relationships between different genera and species, will not enable the ordinary collector readily to determine the family of a shell he wants to identify. For it is based on soft and perishable parts of

¹ As the characters of the *radula* cannot be determined without microscope and dissecting facilities, many of the genera defined by Thiele and others primarily by reference to them have had to be defined below in such a way as to include a group of species not completely identical with that included by Thiele, and often much larger. So far as Madras shells go—and I have no wider experience to bring to bear upon the subject—the definitions I have used seem to give a perfectly natural grouping, as well as the most convenient one for the general collector whose needs this paper aims at meeting.

² The apple snail, *Pila*, of the family Ampullariidae (subclass *Streptoneura*) though often found on the sands beside backwaters, is not included as it is really a fresh-water species, not even estuarine. Its shell is large but not very thick, with a horny skin when fresh, more or less spherical in general form, with broad tumid whorls and big aperture closed by an operculum in life. Smaller fresh-water snails with more elevated spire, belonging to the genera *Vivipara* and *Melania*, which are also found, have been omitted for the same reason. Their shells resemble those of *Pila* in texture, and like them are operculate.

the animal which he rarely finds and probably has no convenient means of preserving. To meet this difficulty a key based solely on shell characters has had to be drawn up, though much of it necessarily bears little or no relation to the natural classification. Some families will therefore be found split into sections appearing in widely separated parts of it, and exceptions will almost certainly be found to some of the definitions used, especially in the case of species foreign to Madras with which this key is not directly concerned. The use of characters found in the operculum has so far as possible been avoided, because the operculum commonly disappears with the animal. When found, however, it can be preserved dry like the shell, and where no other definite character seems to be available that of the operculum has been used. Radula characters are not used at all, for the radula not only disappears with the animal but is difficult to extract without dissecting facilities and impossible to examine without a microscope.

The following will, I hope, provide a reasonably convenient means of placing Madras shells in their respective families.—

- | | | | | |
|--|-----|--------------------------|--------------------|----------------------|
| 1. Shell irregularly uncoiled, often attached | ... | ... | ... | VERMETIDAE, p. 23. |
| — Shell not uncoiled, more or less regular, never attached, | | | | |
| spire sometimes obsolete | ... | ... | ... | 2 |
| 2. Shell as in fig. 15, 7 (p. 82) | ... | ... | ... | CAVOLINIIDAE, p. 86. |
| — Shell not of this form | ... | ... | ... | 3 |
| 3. Spire absent or rudimentary; aperture very large, at least | | | | |
| when shell is greatly flattened | ... | ... | ... | 4 |
| — Spire clearly developed, though sometimes completely | | | | |
| enclosed within body whorl, aperture relatively smaller; | | | | |
| or shell not flattened | ... | ... | ... | 12 |
| 4. Shell hard and at least moderately thick, almost always more | | | | |
| or less conical or sometimes nearly flat (limpets, etc.) | ... | | | 5 |
| — Shell not conical, usually very thin or imperfectly calcified | | | | |
| (tectibranchs, part) | ... | ... | ... | 60 |
| 5. Shell flattened but spiral throughout | ... | ... | ... | 6 |
| — Spiral confined to apex or absent | ... | ... | ... | 7 |
| 6. Shell pearly within, body whorl with line of perforations for | | | | |
| reception of tentacular processes of mantle | ... | ... | HALIOTIDAE, p. 13. | |
| — Shell not pearly within, body whorl without perforations | ... | NATICIDAE (part), p. 36. | | |

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7. A thin plate (representing the spire) attached to under surface 8
 — No such internal plate. Shell conical, regular, but not always symmetrical 9
8. Shell more or less regular, bilaterally symmetrical, convex, apex marginal or submarginal, more or less dark in colour. NERITIDAE (part¹), p. 18.
 — Shell less regular and symmetrical, often conical or flattened and of a whitish or light brownish colour CALYPTRAEIDAE, p. 35.
9. Apex spiral HIPPONYCIDAE, p. 34.
 — Apex not spiral 10
10. Shell symmetrical 11
 — Shell more or less asymmetrical on account of a shallow radial channel on under surface of right side SIPHONARIIDAE, p. 87.
11. Shell entire, without even an indication of a fused up slit ... PATELLIDAE, p. 13.
 — Shell perforated at or near apex, or with a slit or light indentation or emargination in front margin, or with line on its under side representing fused lips of such a slit ... FISSURELLIDAE, p. 13.
12. Shell with more or less distinct pearly² lustre inside or on base of columella, usually thick; anterior canal absent ... 13
 — Shell not pearly, often porcellaneous inside 14
13. Operculum horny TROCHIDAE, p. 14.
 — Operculum stony TURBINIDAE, p. 17.
14. Shell much flattened, or conical with flattened base, width of which exceeds height of spire. Body whorl not inflated, aperture not very large 15
 — Shell taller than broad, or aperture very large. Body whorl often inflated 17
15. Shell minute, colourless, flattened, umbilicus present ... CYCLOSTREMATIDAE, p. 17.
 — Shell larger, usually conical 16
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¹ No Neritids of this type have yet been found at Madras, but as they occur a little further south at Porto Novo it seems likely that further search may reveal them.

² This pearly lustre is apt to disappear in bleached shells, and is not always easy to detect even in fresh ones such as the little button shell (*Umbonium*), a shell distinguished from all others found at Madras by its flattened form and smooth surface, combined with the absence of any trace of an umbilicus.

16. Umbilicus very large, forming mouth of broad conical cavity extending through whole length of columella ... ARCHITECTONIDAE, p. 23.
 — Columella normal, umbilicus often closed, upper surface of shell usually with small stones, shells, etc., cemented to it. XENOPHORIDAE, p. 35.
17. Aperture without definite anterior canal¹, its margin being at most angular or lightly sinuate in front; spire exposed ... 18
 — A definite anterior canal present, or spire completely concealed within body whorl ... 33
- 18². Spire much elevated, its whorls usually numerous, body whorl not much enlarged, its terminal part at most about twice as deep as exposed part of penultimate whorl and usually much less, height of shell more (usually much more) than twice maximum breadth ... 19
 — Spire less elevated, its whorls not very numerous, terminal part of body whorl not less than about twice as deep as exposed part of penultimate whorl and usually much more, height of shell not more than about twice maximum breadth, commonly less ... 24
19. Apex sinistrally coiled, either depressed or bent to one side, rest of shell dextral. Columella often with one or more folds, shell not very large, often minute ... PYRAMIDELLIDAE, p. 30.
 — Apex dextral like rest of shell, columella without distinct folds ... 20
20. Top of spire abruptly narrowed, apex styliform. Very small shells parasitic on sea urchins, etc. ... STYLIFERIDAE³, p. 30.
 — Apex normal ... 21

¹ By a definite anterior canal is here meant one which is recognisable as a distinct groove by reason of its length or of its being bounded by ridges or folds, or of its terminating in front dorsal to the end of the columella, i.e., beside rather than within the general outline of the aperture. Thus the Ringiculidae are regarded as having a definite canal, but the Acteonidae are not; for, though some of the latter have a fold on the columella that might seem to define it on one side, this is not situated so far forwards as in the former with the result that the termination, even when somewhat produced, forms part of the general outline of the aperture and is not clearly distinguishable from it even on its inner side. The Janthinidae are also regarded as being without a definite anterior canal for, though the aperture is usually angular in front, this results merely from the shape of the shell and there is nothing to demarcate either side of any canal. The Harpidae are in some degree transitional as they may have an anterior notch defined by a slight angle on the outer side and slightly overhung by the end of the columella. Thiele, however, describes them as being without canal, so I follow his lead. The Cancellariidae are likewise placed in the group without it.

² Some species of Littorinidae are more or less transitional between these two groups. They have been included under section 24 where the rest of the family definitely belongs. *Kleinella diana*, which though somewhat slender has a very large body whorl, is included with the rest of its genus under section 19.

³ *Eulima attenuata* of the family Eulimidae also has a somewhat styliform apex but is a larger shell.

21. Shell unsculptured, smooth and glossy, never thick, whorls rarely even moderately inflated EULIMIDAE, p. 29.
- Shell less markedly or not at all smooth and glossy, usually sculptured, often somewhat thick, whorls as a rule at least slightly inflated 22
22. Whorls as a rule distinctly round in profile, often encircled by a series of transpiral crests ; spiral sculpture, when present, either underlying these crests or superimposed on almost microscopic transpiral sculpture or consisting of lines of almost microscopic punctures ; in the last two cases, and when shell is decorated with smooth transpiral ribs, base of body whorl either differently sculptured from rest or unsculptured, and demarcated from rest by spiral ridge or fine line extending from near top of aperture EPITONIIDAE, p. 27.
- Whorls somewhat less clearly inflated, not encircled by transpiral crests, body whorl more or less uniformly sculptured throughout 23
23. Shell never large, often more or less minute, lip usually somewhat thick¹, sculpture of various types RISSOIDAE, p. 21 ; and FINELLIDAE, p. 26.
- Shell large with more or less distinct spiral ridges, lip more or less thin TURRITELLIDAE, p. 21.
24. Aperture more or less broadly rounded, shell not tapered in front, sometimes very thick 25
- Aperture somewhat long and narrow, shell never very thick, always taller than broad, usually somewhat tapered at both ends and thus more or less spindle shaped 32
25. Columella with folds, operculum absent, either strong transpiral ribs or latticed sculpture present CANCELLARIIDAE, p. 67.
- Columella without true folds, sometimes toothed, usually smooth 26
26. Shell ornamented with series of strong and regularly spaced transpiral ribs HARPIDAE, p. 67.
- Transpiral ribs absent 27

¹ The lip is thick in most of the Rissoids I have seen, thin in the only Finellid.

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27. Umbilicus present (rarely covered), columella without callosity FOSSARIDAE, p. 34.
 — Umbilicus absent ¹ or columella with callosity 28
28. Operculum absent. Pelagic snails with thin shells, usually of a bluish violet colour JANTHINIDAE, p. 28.
 — Operculum present, or shell somewhat thick 29
29. Body whorl not particularly large in proportion to spire, spire usually elevated, umbilicus never present¹, shell not as a rule very thick 30
 — Body whorl large in proportion to spire, always very large unless umbilicus is present, spire often depressed, shell usually thick 31
30. Operculum horny LITTORINIDAE, p. 19; and ASSIMINEIDAE², p. 21.
 — Operculum stony TURBINIDAE (part)³, p. 17.
31. Columella more or less wedge shaped, sometimes toothed, often reducing an abnormally thick-lipped aperture to a relatively small D-shaped one, umbilicus absent NERITIDAE (part), p. 18.
 — Columella and aperture normal, columella with more or less pronounced and often very large callus, umbilicus present or closed by callus NATICIDAE (part), p. 36.
32. Outer lip of aperture without teeth ACTEONIDAE, p. 83.
 — Outer lip of aperture with teeth ⁴ ELLOBIIDAE, p. 86.
33. Shell very small but relatively thick, colourless, glossy, with aperture at least moderately broad but more or less reduced by thickened lip on outer side and strong folds of columella on inner RINGICULIDAE, p. 83.
 — Shell not as above, usually much larger 34
34. Anterior canal united with umbilicus and twisted upwardly towards the right, shell inflated, aperture broad or linear, its inner border often with broad flattened folds CASSIDIDAE, p. 41.
 — Anterior canal normal 35
-

¹ Present in some Assimineidae, but not in the Madras species.

² Some Assimineidae have the operculum stony, but not the Madras species.

³ The subfamily Phasianellinae.

⁴ *Melampus avenaceus* is an exception. It is a minute white shell likely to be mistaken for an Acteonid.

- 35¹. Spire much elevated and base of shell rounded or flattened,
body whorl not much enlarged 36
- Spire less elevated and body whorl more enlarged, or base
of shell more or less tapered 39
36. Spire very long and slender, whorls very numerous ... TEREBRIDAE, p. 79.
- Spire broader in proportion to its height, whorls either less
numerous or several times as broad as high 37
37. Surface glossy, more or less pale in colour, greater part of
it smooth NASSIDAE (part) ², p. 57.
- Surface duller or of a more or less dark brownish colour,
often strongly tubercular 38 ³
38. Operculum with central nucleus, anterior canal often
bordered on outer side by large flat angular process of lip POTAMIDIDAE, p. 24.
- Operculum with excentric nucleus, lip without flat angular
process CERITHIIDAE ⁴, p. 26.
39. Aperture variable in shape but usually elongate, its inner
margin more or less normal, its outer one usually modified
in adult by thickening or eversion or both, often with
teeth or long processes in hindermost of which spire may
be immersed. Shells mostly of at least moderate size ... STROMBIDAE ⁵, p. 35.
- Shell not as above 40

¹ Certain augur shells (Terebridae) and slit lips (Turridae) are very much alike in shape, but the former always have the lower part of the outer lip at least somewhat more rounded above the short anterior canal than do the latter.

² Also *Babylonia zeylanica* of the family Buccinidae.

³ Also *Pyrene (Aesopus) japonica*, and perhaps *Pyrene (Parviterebra) thyraea*, though the latter is really excluded by its more tapered base (see section 35). Both belong to the family Pyrenidae for which, however, they are unusually slender. They have fewer whorls than the Potamididae and Cerithiidae. *P. thyraea* is small and *P. japonica* minute.

⁴ Mr. Crichton has recently collected two or three species of the closely allied, but almost always sinistral, family of more or less small shells, Triphoridae.

⁵ The highly modified foot (see below, p. 35) makes this family very easy to define by reference to the animal, but its shells show such a wide range of form that it is a peculiarly difficult one to define by reference to them alone. Young specimens, and species in which the outer margin of the aperture is not strongly modified, are likely therefore sometimes to be confused with whelk-like shells (section 40 of this key, first group) among which they agree most closely as regards the characters used in this key with the Pyrenidae, some species of which have moreover the outer margin of the aperture thickened and internally ridged much as in some Strombidae. Generally speaking, however, Strombids are much larger than Pyrenids which are always somewhat small. Very few species of Strombidae have been found at Madras, and none are common.

40. Spire and aperture normally developed; body whorl, when large in proportion to spire, almost always inflated and with large aperture; anterior canal often more or less elongate; texture of surface differing in different species (whelk-like shells) ... 41
- Spire less high than body whorl and often entirely concealed within it. When spire is exposed, aperture long and narrow; when spire is concealed, aperture variable and anterior canal either not prolonged or prolongation balanced by similar posterior prolongation. Surface (except in some Volutidae) smooth and more or less glossy (cowries, olives, bubble shells, etc.) ... 55
41. Varices (indicating close of each growth period) conspicuous either as strong ridges or as lines of spines ... 42
- Varices not prominent, usually absent ... 44
42. Posterior canal absent ... 43
- Posterior canal present ... BURSIDAE, p. 44.
43. Varices smooth or nodular or at most strongly toothed, more or less thick; columella usually with more or less distinct folds ... CYMATIIDAE, p. 43.
- Varices usually decorated with long spines or stout foliaceous processes, sometimes forming delicate frills, rarely more or less smooth; columella without folds ... MURICIDAE (part), p. 46.
44. Shell large and massive, more or less pear shaped, its shoulder with line of nodules or processes¹ ... 45
- Shell not as above ... 46
45. Columella with folds ... VOLEMIDAE, p. 57.
- Columella without folds ... VASIDAE, p. 65.
46. Upper part of outer margin of aperture notched or hollowed, often deeply but sometimes almost imperceptibly; spire more or less slender, anterior canal often elongate ... TURRIDAE, p. 69.
- Outer margin of aperture entire ... 47

¹ Certain species of *Thais* (Muricidae), particularly *T. carinifera*, are very like shells of this group, but besides being smaller are not pear shaped, being less produced in front with the anterior canal shorter.

47. Both spire and anterior canal more or less elongate, often very strongly so	FASCIOLARIIDAE ¹ , p. 62.
— Anterior canal short; or spire depressed	48
48. Shell somewhat thin, inflated, usually large, spire often depressed	49
— Shell not as above, thicker and generally smaller, usually with more elevated spire and less inflated body whorl ...	50
49. Base of shell rounded	TONNIDAE, p. 45.
— Base of shell greatly produced	FICIDAE ² , p. 46.
50. Aperture more or less narrow and parallel sided; shell gradually tapered below, more or less spindle shaped ...	51
— Aperture rounded, inclined to be broader above than below; shell usually rounded below with anterior canal short, but sometimes rather abruptly narrowed with somewhat longer anterior canal, rarely more spindle shaped	52
51. Columella with folds that are longer behind than in front and are concentrated about the middle of its exposed part or somewhat behind, operculum absent	MITRIDAE, p. 63.
— Columella without folds, operculum horny	PYRENIDAE ³ , p. 53.
52. Edge of operculum often toothed, shell usually glossy, often with elegant sculpture which is mostly transpiral ...	NASSIDAE (part), p. 57.
— Edge of operculum even, shells usually with spiral sculpture predominating	53
53. Prominent ridges and tubercles absent, usually with spiral ridge extending inwards from inner side of posterior canal	PLANAXIDAE, p. 24.
— Shell usually (but not invariably) with prominent ridges or tubercles	54

¹ Some members of the Buccinid genus *Nassaria* are liable to be confused with the Fascioliid genus *Peristernia*.

² *Cymatium retusum*, a triton of unusual shape and without varices, and *Tudicla spirillus*, a chank of unusual shape, have much the same characters as those by which fig shells (*Ficidae*) are here defined. But both have a bulbous body whorl with very slender anterior canal which is much more abruptly produced than in fig shells.

³ A few whelks (*Buccinidae*), especially those of the genus *Engina*, and purples (*Muricidae*, part) have somewhat the same characters as are here used as a guide to the identification of the family *Pyrenidae*. Some slit-lips (*Turridae*) may also be confused, especially minute shells of the genus *Cythara* (as defined below) in which the lip does not always show clearly the characteristic slit or excavation. See also above, p. 8 footnote 5.

54. Surface of shell somewhat coarse-looking owing to lines of growth forming closely approximated flounces which give it a roughened or even frilled appearance, at least towards growth margin ; without distinct periostracum ... MURICIDAE (part ¹), p. 46.
- Lines of growth not as above, surface less coarse-looking or even glossy ; distinct periostracum often present and frequently hairy BUCCINIDAE ², p. 54.
55. Shell ovoid with very high body whorl and small conical spire, thick and highly polished, anterior part at least of columella forming a more or less sharply defined and extensive callus area extending forwards round inner side of anterior canal OLIVIDAE ³, p. 62.
- Shell not as above 56
56. Anterior canal either present or represented by a marginal concavity 57
- Anterior canal completely absent (tectibranchs, part) ... 60
57. Aperture never long and narrow, spire usually well developed, when internal the aperture very broad ; outer lip not thickened, toothless, columella often with folds ... VOLUTIDAE, p. 67.
- Aperture more or less linear 58
58. Columella without folds ; spire small, often flattened but always external and well developed ; body whorl shaped as an inverted cone CONIDAE, p. 78.
- Columella almost always with folds ; spire commonly more or less internal, completely so when folds are absent from columella 59
59. Anterior canal indistinct or feebly developed, lips of aperture not much thickened, outer lip not as a rule toothed. MARGINELLIDAE, p. 68.
- Anterior canal definitely developed, both lips of aperture usually much thickened and provided with numerous teeth CYPRAEIDAE, p. 39.

¹ The subfamily Purpurinae (purples).

² Also *Cymatium cingulatum*, a triton in which the varices are ill-defined or absent.

³ Some species of Volutidae and immature cowries (Cypraeidae) have somewhat the same characters but are not commonly found. Certain species of *Mitra* (particularly *M. robusta*) may also be confused, but can be distinguished by the conspicuous folds on the columella.

60 ¹ . Spire well developed though often concealed, shell external	...	...	...	...	...	61
— Spire more or less rudimentary, shell internal	...	...	...	...	...	65
61. Coloured spiral bands present, shell thin	...	...	...	...	HYDATINIDAE, pp. 82 and 84.	
— Coloured spiral bands absent	...	...	...	...	...	62
62. Shell somewhat thick and hard, mostly speckled or clouded with pigment, moderately large	...	...	...	...	BULLIDAE, p. 84.	
— Shell thinner and more fragile, mostly white and much smaller	...	...	...	...	...	63.
63. Aperture somewhat broad, its greatest width about equal to that of inrolled spire	...	...	...	...	...	ATYIDAE, pp. 82 and 84.
— Aperture narrow	...	...	...	...	...	64
64. Spire inrolled, shell narrow behind	...	...	...	...	RETUSIDAE, p. 84.	
— Shell more or less parallel sided and cylindrical, spire concealed or elevated	...	...	...	...	...	SCAPHANDRIDAE, p. 85.
65. Small inrolled spire present	...	...	...	...	...	PHILINIDAE, pp. 82 and 85.
— Shell flattened, spire rudimentary, not even inrolled	...	...	...	...	...	APLYSIIDAE, pp. 82 and 88.

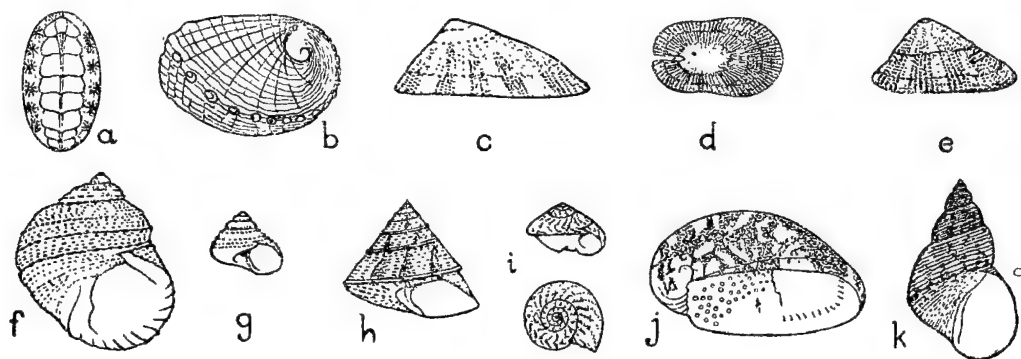


FIG. 1.

- a. *Acanthochiton mahensis*².
 b. *Haliotis varia*.
 c. *Patella cernica*.
 d. *Emarginula incisura*.
 e. *Diodora lima*.
 f. *Euchelus asper*.

- g. *Minolia variabilis*.
 h. *Calliostoma tranquebarica*.
 i. *Umbonium vestiarium*.
 j. *Nerita albicilla*.
 k. *Littorina scabra*.

¹ Section 60, unlike other sections, is derived not from only one but from two previous sections, their numbers being 4 and 56. It includes all Madras tectibranchs (p. 81) except the Acteonidae and Ringiculidae.

² This species belongs to the class Amphineura, dealt with in pt. 1 of this paper. The block was prepared before the division into two parts had been contemplated.

GASTROPODA STREPTONEURA (= PROSOBRANCHIA).

ARCHAEOGASTROPODA (= DOCOGLOSSA + RHIPIDOGLOSSA).

Ear Shells (Haliotidae).

Shell flattened, spire much reduced, body whorl and aperture much enlarged, pearly inside, coloured outside, a line of circular perforations present on body whorl for reception of tentacular processes of mantle ; two bipectinate *ctenidia* (gills), right one smaller than left.

A species of *Haliotis* (fig. 1 b) is said to live in the harbour. I have been unable to confirm this, but Mr. Crichton has collected a small and fragmentary shell on the beach. Mr. Winckworth informs me that *H. varia*, Linnaeus, is the only species he has seen from any south Indian locality.

Key-Hole and Slit Limpets (Fissurellidae).

Shell conical, mantle and shell with hole at or near apex, or a slit (or traces of a slit) in front margin, for respiration and removal of excrement.

Diodora lima (fig 1 e) is the commonest member of this family in Madras. It lives among bivalves attached to piers in the harbour. Both it and *D. townsendi* of which Mr. Crichton has a single shell found on the beach, have the apex perforated, that of the former being more elevated and angular, that of the latter more depressed and rounded. *Emarginula peasei* and *E. incisura* (fig. 1 d), of each of which Mr. Crichton has a single specimen from Madras, both have a slit in the front margin. In the former the sides are evenly rounded and the radial ribs are narrow and rather widely separated with concentric ribs between. In the latter the sides are lightly concave and the radial ribs broader and so close together that the concentric ones hardly show. *Scutus unguis*, of which Mr. Crichton has several Madras specimens, is elongate and somewhat flattened with the front margin lightly concave but without a slit.

True Limpets (Patellidae).

Shell conical, without spire, somewhat depressed, without perforation or fissure, often with radial markings or raised or roughened ribs ; *ctenidia* absent, respiration being effected by a circle of pallial gills beneath the mantle.

Though their shells are not often washed up on the sands, limpets are common on the harbour arm and on the concrete blocks by which it is protected, where they sometimes grow to nearly two inches in length. Though very variable in shape, roughness and colouration they belong to a single species (fig. 1 c), which seems to be identical with *P. cernica* from Mauritius. But this identification has to be considered tentative till it can be checked by examination of the soft parts of a specimen from Mauritius, only the shell having yet been

described from there. The shell differs from that of *P. radiata*—which seems to be the commonest species on most parts of the South Indian coast where limpets have been collected—in its larger size, smoother surface and flatter profile, and in having a fundamentally 9-rayed instead of 11-rayed colour pattern when dark rays are developed. But in many specimens this character is more or less obscured by the splitting of some of the rays into two or more sections. These shell characters are, however, associated with characters in the animal which are better defined, for the Madras species has larger pallial gills than *P. cernica*, and the anterior ends of its U-shaped shell-adductor muscle are joined together by a muscular band which is narrower and extends further forwards than in that species.

A second species has been collected from Mahabalipuram and Covelong, with a single specimen from Madras. It is less than an inch in length, somewhat narrower than *P. cernica*, smooth or very lightly radially striate, of a dull brownish colour with only fragmentary traces of dark rays which seem, however, to be fundamentally nine in number. The pallial gills are very like those of small specimens of the common Madras species and the muscular band between the ends of the shell adductor extends forwards as in that species but is somewhat broader as in *P. radiata*. Neither this species nor a third of which there are four shells from Covelong in the Museum collection have yet been identified. This last species has much the same shape as the common one but is even smaller than the last, smooth and glossy, brownish with dark rays, probably fundamentally 9 in number but more or less irregularly broken much as in Reeve's figure of *P. lentiginosa*.

Top Shells, Button Shells, etc. (Trochidae).

Shell usually pearly, spire typically forming a simple straight-sided cone with flattened base, but often with whorls inflated instead, sometimes much flattened; operculum horny; ctenidium single.

The different kinds of Trochidae found in the neighbourhood of Madras may be identified with the aid of the following key :—

- | | | |
|---|--------|---|
| 1. Shell conical with elevated spire, whorls of which are not inflated or angular | ... .. | 2 |
| — Whorls inflated or angular; or spire depressed | ... .. | 4 |
| 2. Whorls with strong and more or less distinctly double spiral ridge immediately above suture, followed by more or less weak spiral grooves on upper part of surface | | <i>Calliostoma tranquebarica</i>
(fig. 1 h). |
| — Whorls with strong spiral sculpture throughout but without prominent basal ridge | | 3 |

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- | | | | | | | | | |
|---|-----|-----|-----|-----|-----|-----|-----|---|
| 3. Shell large with flattened base, its spiral ridges strongly granular | ... | ... | ... | ... | ... | ... | ... | <i>Trochus stellatus.</i> |
| — Shell small with base not flattened, its ridges smooth | ... | ... | ... | ... | ... | ... | ... | <i>Gibbula stoliczka.</i> |
| 4. Whorls inflated, spirally ridged throughout, the ridges all granular. Shell not very small | ... | ... | ... | ... | ... | ... | ... | 5 |
| — Few if any of the spiral ridges granular. Shell more or less small | ... | ... | ... | ... | ... | ... | ... | 9 |
| 5. Umbilicus without toothed margin, often closed. Shell moderately large | ... | ... | ... | ... | ... | ... | ... | 6 |
| — Umbilicus with toothed margin, widely open. Shell smaller | ... | ... | ... | ... | ... | ... | ... | <i>Clanculus microdon.</i> |
| 6. Whorls moderately inflated, suture in somewhat narrow groove, granules on ridges circular | ... | ... | ... | ... | ... | ... | ... | 7 |
| — Whorls strongly inflated, suture in broader groove, granules on ridges more or less transpirally elongate and crested | ... | ... | ... | ... | ... | ... | ... | 8 |
| 7. At most two ridges more or less distinctly stronger than others | ... | ... | ... | ... | ... | ... | ... | <i>Euchelus asper, s. str.</i> (fig. 1 f.) |
| — Three strongly crested ridges present | ... | ... | ... | ... | ... | ... | ... | <i>E. asper var. tricarinata.</i> |
| 8. Three very stout ridges on each whorl of spire, usually one more on body whorl | ... | ... | ... | ... | ... | ... | ... | <i>Euchelus circulatus, s. str.</i> |
| — Ridges approximately uniform in height, though one or two are generally narrower than the rest | ... | ... | ... | ... | ... | ... | ... | <i>E. circulatus var. proxima.</i> |
| 9. Whorls with hollowed vertical sides (usually with one raised spiral line) separated by strongly crested shoulder from oblique upper part; spire elevated, umbilicus open | ... | ... | ... | ... | ... | ... | ... | <i>Conotrochus holdsworthana</i> ¹ . |
| — Whorls without vertical sides, spire usually depressed | ... | ... | ... | ... | ... | ... | ... | 10 |
| 10. Umbilicus well developed, whorls spirally ridged or grooved | ... | ... | ... | ... | ... | ... | ... | 11 |
| — Umbilicus and spiral sculpture absent, spire depressed | ... | ... | ... | ... | ... | ... | ... | <i>Umbonium vestiarium</i> (fig. 1 i). |
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¹ The genus to which this species should be referred is in some doubt, and Mr. Winckworth suspects that it may have to be transferred to *Solariellopsis*. According to Thiele *Solariellopsis* is identical with *Calliotropis* of the subfamily Margaritinae, while *Conotrochus* is scarcely distinguishable from *Minolia* which he regards as a section of *Isanda* of the subfamily Umboniinae.

11. Shell not very small, spire elevated and decorated with series of spiral ridges, all much alike and none of them sculptured *Minolia variabilis* (fig. 1 g).
 — Shell smaller, spire less elevated (usually depressed) with ridge next suture enlarged and more or less distinctly sculptured as a rule 12
12. Spire somewhat elevated, ridge below suture at most obscurely sculptured, other spiral lines absent *Minolia biangulosa*.
 — Spire depressed, more or less distinct spiral lines present below sculptured ridge 13
13. Uppermost ridge of each whorl obscurely sculptured ... *Minolia sp.*
 — Uppermost ridge of each whorl very strongly sculptured ... *Minolia impressa*.

Caliostoma tranquebarica is the only shell of this family at all frequently found at Madras with the broad and flat-based conical form with sharply pointed apex, the resemblance of which to a peg-top has given the family its popular name ; and even this species is far from common. It is a somewhat delicate shell, of a mottled brownish colour when fresh.

Trochus stellatus (which is very rare at Madras) also has this shape, but is a much stouter shell. I have only seen a single specimen of it that could be identified with certainty—a very large reddish dead shell found lying among the concrete blocks beside the harbour entrance. I feel confident, however, that a very small live specimen found on a concrete block on the eastern (seaward) side of the harbour arm must also belong to the same species, though it is too small for satisfactory comparison with large specimens and no intermediate ones are available. It is obliquely banded transpirally with dark red and white.

Euchelus asper, the inflated whorls of which give it more the appearance of a turban shell than of a typical top shell, lives in great abundance in certain parts of the harbour and is sometimes washed up on the beach, but almost always badly broken. The characters distinguishing its variety *tricarinata* from the typical form, though common in young shells, do not seem to be found in older ones. *E. circulatus* is much less abundant. It seems to bear much the same relation to its variety *proxima* as *var. tricarinata* does to the typical form of *E. asper*, and specimens are even sometimes found in which the upper whorls have the *circulatus* form and the lower ones the *proxima* form.

The little button shell, *Umbonium vestiarium*, may sometimes be found living in enormous numbers in sand covered by shallow water at the seaward end of the Ennur backwater. It is a small shell, rarely reaching half an inch in diameter though sometimes slightly larger, much flattened, with the margin rounded. It is exported for the decoration of boxes,

its glossy surface and delicate and varied colouring making it peculiarly attractive. It is usually banded or otherwise decorated with brown or grey and white or pink, but may be more uniformly of one or other of these colours.

Cyclostrematidae.

Shell small, porcellaneous (not pearly), colourless, usually much flattened but sometimes more or less spherical, umbilicus open and usually large. Operculum horny with several whorls.

At least four or five species occur, but none very commonly. The least scarce is *Cyclostrema eburneum*, an exquisite little shell with denticulately crested margin and on each whorl one spiral ridge a little below the middle which is crossed by a series of obliquely transpiral ridges. The only other species yet identified is *C. bushi* (fig. 2 a), with somewhat similar but much stronger sculpture. Most of the specimens collected were taken alive from a piece of brick in the Adyar backwater, but these were all of very small size—much smaller than the one figured, the natural size diameter of which is indicated by the line beside the enlarged illustration.

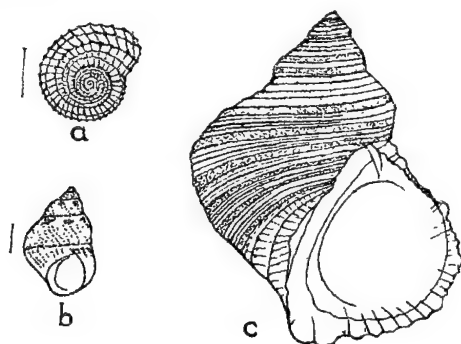


FIG. 2.

a. *Cyclostrema bushi* (enlarged).

b. *Phasianella indica* (enlarged).

c. *Turbo brunneus*.

Turban Shells, Pheasant Shells, etc. (Turbinidae).

Operculum stony, without any process (*apophysis*). Turban shells (subfamily Turbininae) are pearly within, with more or less round aperture. They closely resemble top shells but the straight-sided conical form is unusual among them, inflated whorls being normal instead of the reverse. Pheasant shells (subfamily Phasianellinae) are not pearly within and have a more egg-shaped aperture. They mostly have a taller and more pointed spire.

The common south Indian turban shell, *Turbo brunneus*, was long unknown from Madras. And as it is a big, solid shell the conclusion seemed inevitable that it did not occur anywhere in the neighbourhood. When, however, concrete blocks were examined

in the angle between the two branches of the harbour arm adjoining the harbour entrance, a few of those on the seaward margin were found to be literally swarming with specimens, many of them very large. But as yet it has been found nowhere else in the neighbourhood. Its almost hemispherical operculum is sold at Rameswaram as the eyes of Ravana, the demon king of Ceylon who plays such an important part in the Hindu epic Ramayana. The exposed surface of the operculum is convex with reticulate sculpture on its outer part, the other surface is flat with spiral line.

A single large fragment of the body whorl of the giant turban shell *Turbo marmoratus* has been picked up at Ennur. Being one of the best commercial sources of mother-of-pearl, it may have come there through human agency.

Pheasant shells are represented by a single small species, *Phasianella (Tricolia) indica* (fig. 2 b), usually with brownish mottlings on a pale ground with darker patches below the suture and a straw-coloured band, with or without dark patches, at the periphery, a band which varies considerably in different specimens. The true height is indicated by the line beside the figure.

Neritidae.

Shell with very low spire, the internal walls of which are often absorbed; without umbilicus or pearly layer. Operculum stony, provided on inner side with stout projection.

Of the two principal genera, *Nerita* and *Neritina*, the former is exclusively marine, living mostly on rocks exposed to waves. It has a very thick shell and attains a comparatively large size. The latter is mostly found in estuarine or fresh water, has a somewhat thinner shell and is smaller in average size.

Nerita albicilla (fig. 1 j) sometimes attains its full size on concrete blocks in Rayapuram bay and on the low rocks beyond it. In the harbour it never seems to grow to more than half this size, but at the bottom of the steps about half way along the arm it is sometimes common, occasional specimens of *N. chameleon*, also small, occurring there with it. A few well grown specimens of *N. chameleon* have been taken from concrete blocks in Rayapuram bay beside the harbour entrance. In *N. albicilla* the spire is so low as scarcely to reach the level of the upper extremity of the outer lip, and the broad exposed surface of the columella is tuberculate beside the spire in young specimens and almost throughout in adults, but neither this surface nor the inner surface of the outer lip is definitely ridged. In *N. chameleon*, on the other hand, the spire is slightly elevated above the body whorl, while the outer and sometimes less distinctly the inner border of the columella surface, and the inner surface of the outer lip, are ridged, their tubercles being confined to a few in the middle part of the columella surface of well grown specimens.

Neritina (Smaragdia) oualaniensis and *N. (s. str.) siquijorensis*, *crepidularia*, and a blackish species allied in the shape of its spire to *N. aciculata* but with fine spiral sculpture,

are to be found in the Adyar backwater. *Neritina oualaniensis* is a small shell with spire somewhat more elevated than in *Nerita chameleon*. In *Neritina siquijorensis* the spire is depressed as in *Nerita albicilla*. In *Neritina crepidularia* it is still smaller and is situated approximately in the middle line, much as in *Hipponyx* (fig. 5 c). In the blackish species the spire, though small, is elevated with a curious abruptness except in very small shells. The most distinctive features of this species seem, however, to be its fine but very distinct spiral and radial sculpture and its dull brownish black colour. *Nerita oualaniensis* is an olive greenish or brownish shell, closely marked with fine dark and irregular transpiral lines and with forwardly pointing triangular pale patches which sometimes unite to form pale spiral bands thus losing more or less completely their triangular shape. *N. siquijorensis* grows to a much larger size than *N. oualaniensis* and than the single well grown specimen of the blackish species that I have seen. Large specimens of *N. siquijorensis* are decorated with transpiral lines of brown spots or backwardly pointed triangles on a black background, but very small ones are reddish with less regularly arranged whitish spots of similar shape which may be concentrated to form spiral bands. *N. crepidularia* is not unlike *N. siquijorensis* in colour in its different stages, but its spots tend to be somewhat less triangular or may be replaced by bands radiating from the spire. Only two small specimens of it have been found at Adyar.

TAENIOGLOSSA (= MESOGASTROPODA) PLATYPODA.

Winkles (Littorinidae).

Marine or terrestrial snails with monopectinate ctenidium. Shell not unlike that of a small whelk, but with margin of aperture unbroken by canals. The special interest of this family lies in the way in which many species have left the sea and adapted themselves to a more or less amphibious or terrestrial life.

• Several species of *Littorina* are abundant on the harbour arm. *L. undulata* is found chiefly at about the surface level of the water, though it occurs at higher levels too and particularly large (but much corroded) specimens about $\frac{3}{4}$ " long have been found in cavities in concrete blocks level with the top of the arm but washed by spray. Its colour usually harmonizes with that of the ground frequented, but as individuals probably wander from one type of ground to another the correlation is only a general one. On dark wood it is usually very dark brown, generally with traces of pale markings which sometimes become more extensive. Such specimens are almost invariably finely and uniformly spirally grooved, and never seem to attain any large size, their maximum length being about half an inch. On the band of oysters at about low tide level, however, larger specimens are found (up to about $\frac{5}{8}$ ") more or less whitish in colour, usually decorated with wavy dark or light brown bands of varying width and pattern, sometimes coalescing to produce whitish patches on a brown background. In such specimens spiral grooving may also be present but is usually

absent. Similar specimens are sometimes found attached to the bottoms of boats, which are always beached when not in use and are much paler in colour than the more or less perpetually wet wood of the harbour.

L. subgranosa is a much smaller shell living on rocks and concrete blocks from between tide marks to as far above as they are periodically wetted by spray, the wide range of variation it shows both in shape and in colour being to some extent correlated with the degree of wetting to which it is subjected. The vast majority of specimens found at Madras belong to the variety *eudeli*. This variety lives in the wettest places and is relatively tall, very dark in colour, with spiral lines of white spots of varying number and distinctness. The surface is somewhat uneven and usually appears somewhat corroded, thus obscuring sculpture, though more or less distinct spiral sculpture is commonly present. This variety is not very sharply differentiated from *L. subgranosa*, *s. str.*, which lives above high tide mark. This latter form is a somewhat broader and paler shell with well marked spiral semigranular striations, the whorls being somewhat more inflated and the spire less elevated. The form nearest to var. *eudeli* is a brown shell with the white markings tending definitely to be concentrated on the semigranular spirals, but typically it is a pale shell with somewhat irregular brownish markings. With it at the highest levels a third form about equally well differentiated is occasionally found, which agrees in all particulars with Reeve's figure and description of his *L. novae-zealandiae*.¹ In it the spiral striations are finer, more numerous and more or less smooth and the dark markings are scarcely visible, the shell appearing practically colourless in contrast to the other two forms.

Tectarius (Nodilittorina) malaccanus, a small black shell with spiral lines of strong whitish nodules, is common in moist places such as are frequented by the preceding species, especially by its var. *eudeli*.

In the Ennur backwater, *L. scabra* (fig. 1k) and *L. melanostoma* are to be found as well as *L. undulata*, which is found there on wood. *L. scabra* seems to live there only on the leaves and stems of the White Mangrove, *Avicennia*, though shells are occasionally washed up on to the sand. It has fine and regular spiral striation, is usually of a mottled brownish colour and may attain a length of about an inch and a quarter. It can best be distinguished from similarly coloured specimens of *L. undulata* by the more or less distinctly angular lower surface of the body whorl, that of *L. undulata* being more rounded. In half grown specimens found on *Avicennia* foliage, where they were resting conspicuously on the upper sides of the leaves, a large proportion were much more brilliantly coloured, being red, yellow or whitish, with darker markings along the suture.

¹ Mr. Winckworth considers this to be a distinct species. It certainly appears distinct when found, but is really no more distinct when examined in detail than are typical specimens of var. *eudeli* from typical *subgranosa s. str.* Its characteristics seem, moreover, to be so definitely an intensification of those found in *subgranosa* from the highest levels, where alone it has been found and there only in very small numbers, that I expect a long series would show complete gradation.

A colony of *L. melanostoma* was once found under the shelter of the trailing branches of an old and somewhat woody-stemmed specimen of the salt-marsh herb *Sesuvium* and a single specimen on an *Avicennia* stem. It has a somewhat tall, straight-sided spire, yellowish in colour and with fine spiral grooving, usually varied with oblique straight lines of small squares of a more or less distinct purplish colour.

Rissoidae.

Shell mostly very small, aperture rounded or ovate, sometimes with lip hollowed in front. Snout short, feelers long and twisted with the eyes at their base ; foot long and narrow, pointed behind.

Several species of this family are to be found at Madras, chiefly in the backwaters, but they are very small and little is yet known about them. Of the two genera that have been identified *Cingula* is without a hollow in the front part of the lip and *Rissoina* with one. *Cingula* is represented by a single specimen of *C. oscitans* in Mr. Crichton's collection, a very slender thin-lipped shell with fine spiral sculpture. *Rissoina* is represented by two species. *R. clathrata*, which may be almost half an inch long, is a slender shell with tall spire each whorl of which is ornamented by three or four spiral ridges crossed by numerous transpiral ones, the crossings being somewhat elevated. *Rissoina rissoi* is a still smaller shell with a more elegant series of transpiral ribs only.

Assimineidae.

Shell almost always quite small, mostly ovate-conical ; aperture rounded or ovate, usually angular above, operculum horny or more rarely stony. Proboscis and foot short, sole without median groove, mantle cavity without gills. Land shells or inhabitants of the water's edge.

A tiny reddish snail, *Assiminea rubella* is sometimes found in enormous numbers crawling on wet mud exposed by the falling tide in the *Avicennia* swamps of the Ennur backwater. A brown species, *A. brevicula* has recently been collected by Mr. Crichton at Adyar. Other species are recorded from beside fresh water in Madras¹.

Turret or Screw Shells (Turritellidae).

Shell very long and slender with numerous whorls, margin of aperture without canals. Operculum horny. Head prominent. Mantle border fringed. No siphon. Foot broad and truncate.

¹ *A. woodmasoniana* from a tank in Parasavakkam and *A. hungerfordiana* from the Cooum near Anderson Bridge.

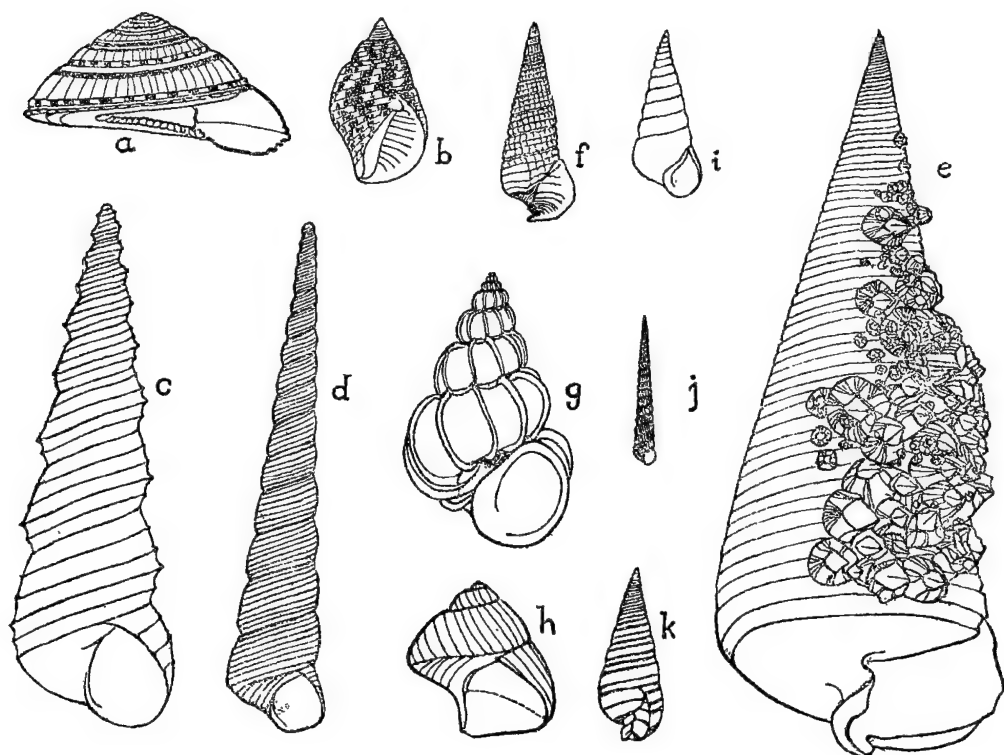


FIG. 3.

a. *Architectonica perspectiva*.b. *Planaxis sulcatus*.c. *Turritella acutangula*.d. *Turritella columnaris*.e. *Telescopium telescopium* (with lip broken)
partly encrusted with the barnacle *Balanus*
amptitrite.f. *Cerithidea fluviatilis*.g. *Epitonium scalaris*.h. *Janthina roseola*.i. *Eulima martinii*.j. *Turbonilla coramandelica*.k. *Pyramidella terebellum* not quite fully
matured.

In shape these comparatively large shells resemble the auger shells and some horn shells, especially the former. They differ from both, however, in having the margin of the aperture entire, *i.e.*, unbroken by any canal.

T. acutangula (fig. 3 c) and *T. attenuata* are the commonest Madras species. Both are of a whitish or pale brownish or bluish colour and have somewhat inflated whorls, usually with more or less distinct spiral raised striations of which (in unworn specimens) that at the widest part is more distinct than the others and may be strongly keeled, often with another almost equally prominent striation either a little above or below it or both. *T. attenuata* is much more slender than *T. acutangula* and tends to have weaker striations and to be more often bluish in colour.

Turritella columnaris (fig. 3 d) is of a mottled pale brownish colour. Its whorls are not inflated and are marked with a close and more or less uniform series of spiral striations, giving it a particularly strong resemblance to an auger shell. In young shells, *i.e.*, also the upper whorls of larger ones, however, two of the striations tend to be stronger than the others.

Staircase Shells (Architectonidae).

Shell more or less depressed, conical with more or less flattened base. Umbilicus open from apex downwards, very wide at base. The sculpture of the umbilicus margin often suggests a spiral staircase, hence the popular name.

Several species of the genus *Architectonica* (= *Solarium*) with much flattened base and angular margin are not uncommon, particularly *A. laevigata* with somewhat elevated spire, rounded sides and double raised marginal band on the base, and *A. purpurata* and *A. perspectiva* with depressed spire, straighter sides and a treble raised marginal band on the base. *A. purpurata* differs from *A. perspectiva* (fig. 3 a) in having the white marginal or submarginal band of the upper border of each whorl interrupted by brown patches and without a dark band immediately below it. *A. aspera* is a much scarcer small brownish shell, differing from specimens of the next genus *Heliacus* chiefly in having the angular margin characteristic of *Architectonica*.

Heliacus stramineus which is also more rarely found, has the base less flattened and the margin, which bears three strong ridges, more rounded. Above and below it is marked with spiral grooves crossed by finer transverse ones of which those above are oblique and those below radial. It is brown in colour. *H. dorsuosus*, which is still rarer, is a similar looking but much smaller shell with only two strong marginal ridges and other small differences.

Mr. Crichton has a single specimen very near *Torinia costata*, but I think distinct. It is a small, much flattened and somewhat brownish shell with two strong ridges on the margin, somewhat closer together than in *T. costata*, the aperture enclosing the lower one instead of being entirely below it. The suture is sunk in a deep spiral groove both margins of which are beaded.

Worm Shells (Vermetidae).

Shell usually attached and more or less irregularly unwound, sometimes regular at first (the distal parts alone being irregular), aperture rounded.

Some of the concrete blocks now well above water level beside the entrance to the harbour bear numerous tubes of a Vermetid belonging to the genus *Siphonium*.

A single specimen belonging to the genus *Siliquaria* (fig. 4 b) is in Mr. Crichton's collection. It is white throughout, but its orbicular apical whorls and beaded spiral fissure suggest that it may be a bleached specimen of the brown *S. tosta* described by Reeve from Ceylon.

Planaxidae.

Shell without umbilicus, smooth or with spiral sculpture, usually with a more or less distinct spiral ridge extending inwards from inner side of posterior canal, outer lip sharp, columella lip with callus which is stout above but flattened below, anterior canal and short pallial siphon present.

Planaxis sulcatus (fig. 3 b) is found abundantly in isolated places among the oysters on the harbour arm with *Nerita* and *Littorina*, and well above high water level on the concrete blocks east of the harbour entrance. It is a somewhat coarse looking, dark greyish shell with whitish markings, spirally grooved and very like a winkle in general appearance but with an anterior canal present. The body whorl is faintly angular below, and the spiral grooves on the outer surface show through as well marked spiral ridges on the inner. The internal spiral ridge beside the suture is very strongly developed. In the Pamban area this species grows to a larger size than is usual in Madras and the ground colour is generally whitish with the markings dark.

Planaxis similis is a small dark brown or blackish shell, usually white or purplish within the aperture, of which populous colonies are sometimes found well above high water level on the outer side of the harbour arm and of the Cassimode revetment. Its internal spiral ridge is much less distinct than is that of *P. sulcatus*.

Telescope Shells, etc. (Potamididae).

Shell with elongate spire and numerous tuberculate or spirally ribbed whorls. Aperture mostly with anterior canal but sometimes only lightly excavate in front. Operculum with central nucleus. Pallial siphon short, snout long. Inhabitants of backwaters.

The species that have been identified from Madras may be distinguished from one another thus. All are special favourites of hermit-crabs—

1. Spire with four spiral ridges, of which the lowest is thread-like and the other three broad and tuberculate, tubercles on each ridge being arranged one on each of a series of faint transpiral ribs which they thus serve to emphasise. Shell somewhat small *Cerithidea fluviatilis* (fig. 3 f).
- Spiral ridges not tuberculate. Shell very large 2
2. Spiral and transpiral ridges narrow, about equally developed, forming a well marked lattice, ribs absent *Cerithidea obtusum*.
- Spiral ridges broad, transpiral ridges absent, ribs sometimes present 3

3. Transpiral ribs more or less distinct, at least towards apex,
all four spiral ridges of about equal size *Terebralia palustris*.
— Transpiral ribs entirely absent, four spiral ribs not all equally
broad *Telescopium telescopium*. (fig. 3 e).

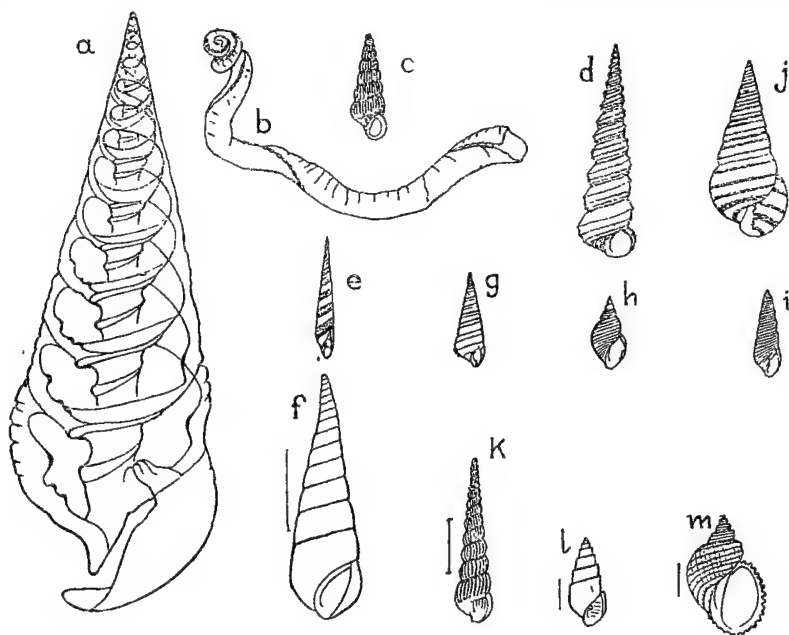


FIG. 4.

- | | |
|--|---|
| a. <i>Terebralia palustris</i> . Optical section to show the two longitudinal lines of internal teeth ¹ . | g. <i>Niso pyramidelloides</i> . |
| b. <i>Siliquaria</i> sp. | h. <i>Kleinella dianae</i> . |
| c. <i>Opalia</i> (<i>Dentiscala</i>) sp. | i. <i>Kleinella fulva</i> . |
| d. <i>Eglisia tricarinata</i> . | j. <i>Pyramidella terebellum</i> fully matured. |
| e. <i>Eulima</i> sp. nr. <i>bivittata</i> . | k. <i>Turbonilla crichtoni</i> (enlarged). |
| f. <i>Eulima acufornis</i> (enlarged). | l. <i>Odostomia babylonica</i> (enlarged). |
| | m. <i>Couthouyia insignis</i> (enlarged). |

The true height of enlarged figures is shown by the line beside each.

Cerithidea fluviatilis is the most characteristic and abundant shell in the backwaters. It has a tall conical shape and is about an inch long when full grown, dark greyish or brownish in general colour with whitish nodules. The aperture is slightly broader than long, this being the character by which it can most easily be distinguished from the less abundant horn shell, *Cerithium granosum*, which sometimes occurs with it.

The other three species are much larger and less abundant, *Terebralia* and *Telescopium* sometimes attaining a length of three or four inches. *Terebralia palustris* (fig. 4 a), when

¹ This drawing is based on X-ray photographs kindly prepared by Capt. T. W. Barnard at the Barnard X-Ray Institute, Madras General Hospital.

complete, has an almost semi-circular and somewhat everted outer lip and shows no folds on the columella. When found in the neighbourhood of Madras, however, it seems always to be inhabited by hermit-crabs and to have the lip and body whorl broken far back. The aperture then appears much higher and narrower, revealing folds on the columella and three teeth within what has become the outer lip, of which the uppermost is very large and the lowest the smallest. These internal teeth are arranged in two lines, one on each side of the shell, the positions of which are marked externally by inconspicuous pairs of varices.

In *Telescopium* the aperture is broader than high and the folds of the columella extend right down to it.

Finellidae.

Shell small with tall spire of more or less inflated whorls, mostly with spiral grooves and often with transpiral ribs; aperture small, ovate, without canal. Operculum rounded with central nucleus and several narrow whorls.

Finella virgata is a minute and slender whitish shell with transpiral fine brown lines, strong ribs and fine spiral grooves. It is periodically very abundant in the Ennur and Adyar backwaters (see Crichton, *Journ. Bombay Nat. Hist. Soc.* XLII, 1941, p. 340).

Horn Shells (Cerithiidae).

Shells of this family closely resemble those of the last, but the operculum has its nucleus situated eccentrically. In some species the front of the lip is not even excavate, though normally there is a definite anterior canal and a complete gradation between these two extremes can be seen if suitable species are examined.

Three species are found in the neighbourhood of Madras, all belonging to the genus *Cerithium*. *C. granosum* is much the commonest and occurs in the backwaters with *Cerithidea fluviatilis*, though in considerably less abundance. It closely resembles that species in shape, size and sculpture but is slightly more slender, tends to have an additional thread-like spiral ridge between the two lowest of the three broad tubercular ones, has the aperture taller than broad instead of the reverse, and is without any specially large projection of the outer lip beside the anterior canal. In young specimens both the interstices between the three rows of granules contain one or more somewhat wavy raised thread-like lines, making such shells look rather different from larger ones.

Cerithium kochi is a smaller, slenderer and rarer shell, scarcely tuberculate and with six spiral bands, the lowest of them as in the preceding species very narrow and scarcely reached by the transpiral ribs which cross the other five.

Mr. Crichton has a single specimen of a third species. This resembles *C. gemma*, except that it has four instead of three spiral lines of tubercles, the upper two lines being whitish throughout while in the lower ones one whitish tubercle alternates with two of a rich brown colour.¹

Ladder Shells (Epitoniidae = Scalidae).

Shell usually very pale, spire more or less elongate, aperture round. Operculum horny, with few coils. Foot short, proboscis long, a pair of horny spines present with their front ends beside the large gills.

The genera found at Madras may be recognized thus.—

- | | | |
|---|--------------------|---|
| 1. Whorls encircled by transpiral crests, base of body whorl not marked off from rest of shell | <i>Epitonium</i> . | |
| — Whorls not encircled by transpiral crests, base of body whorl distinct from rest of shell | | 2 |
| 2. Surface glossy, base of body whorl smooth ; very small and elegant shells with transpiral ribs, lip not thickened ... | <i>Acrilla</i> . | |
| — Surface matt ; shells of moderate size | | 3 |
| 3. Whole surface covered with spiral lines of minute punctures, ill defined transpiral ribs present, an ill defined ridge between base and upper part of body whorl, lip much thickened | <i>Opalia</i> . | |
| — Base of body whorl flattened with spiral lines and fine radial sculpture, marked off by spiral ridge from rest of shell which bears extremely fine transpiral sculpture and strong spiral ridges | <i>Eglisia</i> . | |

Several species of *Epitonium* are found of which the following four, the only ones yet identified, are the ones most likely to be met with :—

- | | |
|---|---|
| 1. Adjacent whorls not in contact, but united by their encircling crests which are very strong, spiral sculpture indistinct or absent, shell whitish | 2 |
| — Adjacent whorls fully in contact, encircling crests finer, shell slender, more than twice as tall as broad, shell pale brownish | 3 |

¹ Mr. Winckworth tells me that this must be *C. lineatum* which he has from the Seychelles and also a poor example from Krusadai Island in the Gulf of Manaar, but that Duncker's name is preoccupied. I therefore suggest that it be called *C. crichtoni*.

2. Shell less than twice as tall as broad, crests simple, aperture D-shaped its posterior angle alone touching one crest of whorl above *E. scalaris*¹ (fig. 3 g).
 — Shell more than twice as tall as broad, upper part of crests and lip with more or less rectangular projection, aperture rounded, touching a series of crests of whorl above ... *E. pyramidalis*.¹
 3. Spiral sculpture indistinct or absent *E. philippinarum*.
 — Spiral sculpture fine but distinct *E. subtile*.

The genus *Acrilla* is represented by a single species, *A. acuminata*, and probably by another closely allied to it.

Mr. Crichton's collection contains a single specimen of *Opalia* belonging to the section *Dentiscala*, in which the lower margin of the suture is toothed. The species (fig. 4 c) has not yet been identified.

Two specimens of *Eglisia tricarinata* (fig. 4 d) have been collected, also by Mr. Crichton. It is a very slender *Turritella*-like shell with three strong spiral ridges in the lower half of each whorl of the spire and one faint one in the upper half. The whitish ground colour is usually faintly clouded with pale brown patches.

Violet Snails, etc. (Janthinidae).

Shell thin, operculum and umbilicus absent. Foot short and broad, secreting a float. Pelagic.

This family contains two genera, *Recluzia* in which the shell is colourless with a brown surface membrane, and *Janthina* in which the shell is of a violet colour, usually somewhat pale. *Recluzia*, possibly *R. jehennei*, has been collected at Pulicat by Prof. S. G. Manavala Ramanujam. *Janthina* is not infrequently washed up on the beach² in company with the similarly coloured pelagic hydroids *Porpita*, etc., on which it probably feeds. *J. roseola* (fig. 3 h) is much the commonest species, but *J. globosa* also occurs at times. *J. roseola* has the body whorl and aperture somewhat flattened below, with the outer margin somewhat angular, the colour being very pale above and dark below, while the suture is not markedly depressed. *J. globosa* has the body whorl and aperture more rounded, with less contrast between the shades of the upper and lower surfaces, while the suture is sunk in a well marked hollow.

¹ Mr. Crichton has recently collected two specimens of a species combining some of the character of *E. scalaris* and *E. pyramidalis*, yet distinct from both and of a browner colour. It is probably *E. pallasii* Kiener.

² See Crichton, *Journ. Bombay Nat. Hist. Soc.* XLII, 1941, p. 329.

Eulimidae.

Spire tall, often very slender, apex regular, whorls usually not in the least inflated, never greatly so, usually smooth and glossy, columella without distinct folds. Foot without mentum.

Of the two Madras genera, *Eulima* is without umbilicus while *Niso* has one.

Five species of *Eulima* have been identified, one of them tentatively ; but several others have been found of which two have been fitted into the following key.—

These seven may be separated as follows.—

1. Aperture nearly three times as high as it is broad, shell slender, spirally banded with brown on a whitish brownish ground 2
- Aperture not more than twice as high as it is broad, shell usually white 3
2. Aperture fully three times as high as broad, shell extremely slender with two fairly well-defined dark brown spiral bands throughout, area between them usually pale brown. Very scarce *E. sp. nr. bivittata* (fig. 4 e).
- Aperture barely three times as high as broad, shell smaller and slightly less slender, brown bands diffuse. Much less scarce *E. bivittata*.
3. Shell slender, very like *E. bivittata* in outline 4
- Shell much broader 5
4. Apical whorls abruptly narrowed almost as in Stiliferidae *E. attenuata*.
- Apex normal *E. sp. nr. attenuata*.
5. Margin of body whorl evenly rounded, shell moderately broad 6
- Margin of body whorl forming a somewhat rounded angle, shell larger and relatively broader *E. martinii* (fig. 3 i).
6. Minute, parasitic on the sea urchin *Temnopleurus toreumaticus*, aperture almost vertical *E. ?oblonga*.
- Considerably larger, aperture markedly oblique, body whorl being somewhat shorter in region of columella *E. acufomis* (fig. 4 f).

Niso is represented by two species only, both of them whitish shells of moderate breadth, spirally banded with brown. *N. pyramidelloides* (fig. 4 g), has three brown bands on the

body whorl, one encircling the umbilicus, one at the widest part and one about two-thirds of the distance from this to the suture. On the spire the first is embedded, the second extends throughout and the third disappears in about the upper third of the shell. In *N. sumatrana* the third band is missing throughout and the whorls are slightly but definitely and somewhat abruptly narrowed from their single brown band to the suture below it.

Stiliferidae.

Spire not much elongated, sometimes depressed, apex usually a minute thorn-like projection, operculum usually absent. Mostly parasitic on Echinoderms.

A single species, *Stilifer sibogae*, has been collected by the Madras University Research Laboratories, parasitic on a small species of sea urchin of the genus *Salmacis*, not yet identified. It is a minute shell with relatively large body whorl, small spire and tiny stiliform apex.

Pyramidellidae.

Apex sinistral, either depressed or bent to one side; aperture without definite canals; columella often with one, sometimes with two or three, folds. A thickened ridge known as the *mentum* present above front part of foot.

Six genera are found, of which Thiele regards *Cingulina* as a subgenus of *Eulimella*. As, however, no other representatives of this genus are known from Madras, and the smaller group is more easily defined than the larger one, *Cingulina* is here retained as a genus.

The Madras genera may be defined as follows but in practice the distinctions given in alternatives 4 and 5 are far from definite, especially those in No. 5.—

- | | | | | | | |
|---|-----|-----|-----|-----|-----|-----------------------------|
| 1. Columella with one large and one or two smaller folds, shell moderately broad | ... | ... | ... | ... | ... | <i>Pyramidella</i> , p. 33. |
| — Columella with one or no folds | ... | ... | ... | ... | ... | 2 |
| 2. Shell smooth or (rarely) with a few weak spirals | ... | ... | ... | ... | ... | <i>Odostomia</i> , p. 32. |
| — Shell sculptured | ... | ... | ... | ... | ... | 3 |
| 3. Spiral sculpture predominating | ... | ... | ... | ... | ... | 4 |
| — Transpiral ribs predominating | ... | ... | ... | ... | ... | 5 |
| 4. Whorls more or less distinctly inflated; or columella fold present | ... | ... | ... | ... | ... | <i>Kleinella</i> , p. 31 |
| — Whorls not in the least inflated, columella fold absent | ... | ... | ... | ... | ... | <i>Cingulina</i> , p. 32. |
| 5. Spire tall, sometimes very slender, columella mostly without distinct fold | ... | ... | ... | ... | ... | <i>Turbonilla</i> , pp. 32. |
| — Spire usually short with apex more or less depressed, columella often with fold | ... | ... | ... | ... | ... | <i>Chrysallida</i> , p. 31. |

The Madras species of *Chrysallida* are as follows¹.—

- | | |
|---|---------------------------------------|
| 1. Columella with conspicuous fold, shell minute with pointed apex | <i>C. epentromidea</i> . ² |
| — Columella fold indistinct or absent | 2 |
| 2. Shell about three times as tall as broad, minute, with blunt apex | <i>C. germaini</i> . ³ |
| — Shell fully four times as tall as broad | 3 |
| 3. Shell minute, apex blunt | <i>C. sykesi</i> . |
| — Shell larger, apex pointed | <i>C. humilis</i> . |

The Madras species of *Kleinella* are as follows.—

- | | |
|--|-------------------------------|
| 1. Spiral ridges narrow and somewhat elevated, the grooves between them with more or less distinct transpiral sculpture | 2 |
| — Spiral ridges broad and flat | 4 |
| 2. Body whorl large, aperture almost as high as spire, transpiral sculpture in spiral grooves strong | <i>K. diana</i> e (fig. 4 h). |
| — Body whorl small, spire much taller than aperture ; minute shells with transpiral sculpture in grooves weak | 3 |
| 3. Shell not more than three times as tall as aperture | <i>K. punctigera</i> . |
| — Shell (except when very small) tall and slender, whorls relatively somewhat smaller | <i>K. sundaica</i> . |
| 4. Shell very slender, whorls of spire little or no higher than broad | <i>K. ceylanica</i> . |
| — Shell less slender, whorls of spire fully one and a half times as high as broad | 5 |
| 5. Shell slender, greyish, whorls not inflated | <i>K. fulva</i> (fig. 4 i). |
| — Shell shorter in proportion to its width, whitish, whorls lightly inflated | <i>K. casta</i> . |

¹ See also p. 33.

² Mr. Winckworth has compared Madras specimens with specimens from the Persian Gulf, whence the species was first described, and tells me that the Madras form is larger with the ribs a little stouter, but he thinks undoubtedly conspecific.

³ The columella fold, which is barely if at all distinguishable in Madras specimens, is strongly marked in the figures accompanying the original description (for reference see below, p. 95).

The Madras species of *Odostomia* are as follows.—

1. Columella fold very prominent, shell whitish, porcellaneous,
not very slender 2
- Columella fold low, shell more slender 3
2. Top of each whorl distinctly broader than bottom of whorl
above it *O. babylonica* (fig. 4 l).
- Spire evenly tapered *O. compta*.
- 3¹. Whorls distinctly more than twice as broad as high, whitish,
side of body whorl opposite outer lip of aperture lightly
rounded *O. dubiosa*.
- Whorls scarcely more than twice as broad as high 4
4. Side of body whorl opposite outer lip slightly rounded,
shell usually brownish *O. attenuata*².
- Side of body whorl opposite outer lip more abruptly
rounded, shell usually greyish *O. ? brunnea*.

The Madras species of *Cingulina* are as follows.—

1. Whorls of spire with three spiral ridges 2
- Whorls of spire with two broad and low spiral ridges 3
2. Spiral ridges narrow, two lower ones prominent and widely
separated with fine transpiral striation between them, top
one much smaller *C. superba*.
- Spiral ridges all broad and flat, separated only by fine linear
grooves *C. trisulcata*.
3. Ridges flattened, separated by a fine linear groove *C. sp. 1.*
- Ridges lightly convex with a slight hollow between *C. sp. 2.*

The Madras species of *Turbonilla* are as follows.—

1. Whorls lightly inflated, their sides lightly convex, colu-
mella fold indistinct or absent 2
- Whorls not inflated, their sides straight, columella fold
distinct 4

¹ The distinctions between these three species are very slight. *O. attenuata* is the commonest of them, *O. ? brunnea* somewhat less common, while of *O. dubiosa* a single specimen only has been collected by Mr. Crichton. They may very possibly all prove to be varieties of a single species in which case the name *brunnea* has priority. A few specimens of a much shorter and distinctly stouter species with side of body whorl even more abruptly rounded than *O. ? brunnea* have also been collected by Mr. Crichton.

² See Crichton, *Journ. Bombay Nat. Hist. Soc.* XLII, 1941, p. 340, concerning the habits of this species.

2. Ribs broader than interstices *T. crichtoni* (fig. 4 k).
 — Ribs not broader than interstices 3
3. No spiral striations between ribs, shell very long and slender. *T. coromandelica* (fig. 3 j).
 — Spiral striations present between bases of ribs, shell shorter
 and relatively broader *T. sp. nr. coromandelica*.
4. Base of each whorl very slightly but distinctly narrower than
 top of succeeding whorl, shell colourless with ribs strong. *T. templaris*.
 — Base of each whorl scarcely if at all narrower than top of
 succeeding whorl, shell either brown throughout or banded
 with brown on either side of suture and more or less
 colourless between, ribs inclined to be slightly weaker ... *T. augusta*.

I feel very doubtful if the last two species are really distinct, in spite of the distinctness of some specimens. If not, the name *templaris* must be used for both. Very similar to them are two other glossy brownish shells not yet identified. In one the whorls are lower and more numerous in the greater part of the spire, but in the upper part very small with the ribs indistinct or absent, forming a long and more or less parallel sided and smooth filamentous apex. In the other the whole shell is more slender but the apex is blunt as in *Chrysalida*, to which genus it may not improbably belong in spite of its comparatively large size.

The Madras *Pyramidella* are as follows.—

1. Shell white, unbanded, columella folds usually rather strong *P. turrita*.
 — Shell more or less strongly banded spirally with brown ... 2
2. Spire with two faint brown spiral lines, one immediately
 above and the other a little below suture, disappearing in
 upper whorls *P. teres*.
- Spire with one or three stronger lines 3
3. Spire with a single brown spiral line immediately above
 suture *P. pulchella*.
 — Spire with three brown spiral lines, two very dark of which
 one is half buried in the suture and one near top of whorl,
 one paler and about a third of distance from former to
 latter *P. terebellum* (3 k & 4 j).

These shells all have the form of simple tall cones, but in large specimens of *P. terebellum* the body whorl is as a rule considerably inflated (fig. 4 j). Mr. Crichton's collection contains, however, a single specimen of *P. pulchella* 17 mm. long, an altogether abnormally large size, the body whorl of which shows no sign of having been inflated.

P. turrita and *P. teres* seem to grade completely into one another and I very much doubt if they are really distinct. The name *turrita* has priority.

Fossaridae.

Shell usually umbilicate and with spiral sculpture, body whorl mostly large, aperture oblique with its columellar lip (which is often produced) united with outer lip. Operculum thin with terminal nucleus, scarcely spiral.

Of the two Madras genera, *Couthouyia* has a more or less elevated and slender, *Fossarus* a more or less broad and depressed spire. The Madras species of both are very small shells. *Couthouyia* is represented by a single species *C. insignis* (fig. 4 m). *Fossarus* is represented by *F. tornatilis*, a somewhat thicker shell with much smaller and more strongly and smoothly ridged spire and larger umbilicus. A still thicker shell in which the spiral ridges do not show through from the inside and the umbilicus is not quite so large may possibly be a distinct species of the same genus.

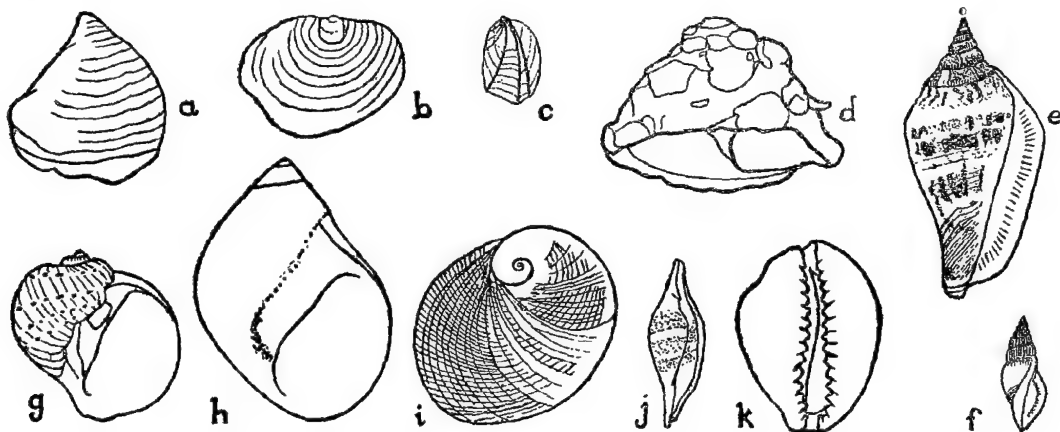


FIG. 5.

- a. *Calyptraea extingtorium*.
- b. *Crepidula walshi*.
- c. *Hipponyx tricarinata*.
- d. *Xenophora corrugata*.
- e. *Strombus succintus*.
- f. *Rimella cancellata*.

- g. *Natica ala-papilionis*.
- h. *Albula mamilla*.
- i. *Sinum neritoideum*.
- j. *Volva sowerbyana*.
- k. *Cypraea moneta*.

Hood Limpets (Hipponycidae).

Shell hood or bowl-shaped, smooth or ribbed, with embryonic shell spiral. Operculum absent, but foot—which is feebly muscular—capable of secreting a ventral calcareous plate.

Much worn specimens of the three-keeled hood limpet *Hipponyx tricarinata* are occasionally washed up. Specimens can sometimes be obtained alive from the north-west corner of the harbour (fig. 5 c).

Slipper Limpets, etc. (Calyptraeidae).

Shell conical or flattened, often with spiral apex which may be either central or terminal. Lateral cervical lobes present. Foot short and circular.

The somewhat irregularly conical crucible shell, *Calyptraea (Crucibulum) extintorium*¹ (fig. 5 a) is often washed up on the beach, and the remarkably flattened slipper limpet, *Crepidula walshi* (fig. 5 b) is sometimes found clinging to the surface of other shells in the Ennur backwater and elsewhere. *Calyptraea extintorium* is very variable in shape and colouring but always has a more or less elevated central apex. Occasionally it is more or less strongly and irregularly radially ribbed, but usually it is smooth, with or without dark small spots or radial lines. *Crepidula walshi* is white, with marginal apex.

Carrier Shells (Xenophoridae).

Snout elongated. Foot divided transversely into two parts, of which the hind one bears the operculum. Shell conical with keeled basal margin, usually with bits of stone, coral or shell cemented to the upper surface.

Three species are occasionally found, *X. indica* in which the shell is bare with large open umbilicus as in a staircase shell and a broad thin and even-edged marginal keel, and *X. solaris* and *X. corrugata* (fig. 5 d) in which it bears bits of shell, etc., cemented to it. In *X. solaris* these fragments are irregularly scattered, the umbilicus is open to the top and moderately large, and the basal margin bears a series of flattened radial processes. In *X. corrugata* the fragments are arranged in a line which follows the spiral of the shell, the umbilicus is small or absent and the basal margin is without processes.

Wing Snails, etc. (Strombidae).

Foot narrow, arched, compressed laterally, without ventral sole, progression being by a jerking movement or by vigorous leaps, instead of by crawling. Snout long. Eye-stalks mostly longer and stouter than tentacles.

Though the unusual character of the foot marks this family off sharply from all others, the shells have such varied forms that it seems impossible to define them satisfactorily. Several particularly well known and distinctive shells are included, such as the fingered wing snails (also known as scorpion shells or spider shells) but they do not seem to occur at Madras, where the family is very poorly represented. The only examples yet met with are small specimens belonging to two species², *Rimella cancellata* (fig. 5 f) and *Strombus*

¹ Concerning the correct name of this species see below, p. 96 footnote.

² Mr. Crichton has since obtained further specimens and records two other species, *Strombus siboldii* Sowerby and ? *S. vittatus* Linnaeus. See *Journ. Bombay Nat. Hist. Soc.* XLII, 1941, p. 332.

succinctus (fig. 5 e). *Rimella* is characterised by a curious prolongation of the posterior canal of the aperture across the lowest whorl of the spire on to the base or even the top of the next whorl¹.

Naticidae.

Foot highly developed and provided with a system of water canals that facilitate burrowing, its front part reflected over head. Eyes very deep-seated or absent. Body whorl of shell usually very large and spire very small, columella lip often with a more or less extensive callus thickening. Operculum spiral with excentric nucleus, usually horny.

Considerable difference of opinion still exists regarding the subdivision of this family into genera. For present purposes it seems best to divide the Madras species into four genera in accordance with the form and structure of the shell as follows.—

1. Callus thickening of columella lip at least moderately strongly developed, spiral sculpture absent, shell not depressed 2
- Callus thickening of columella lip weak or absent, spiral sculpture present though sometimes weak and of limited extent ; or shell markedly depressed 3
2. Body whorl inflated and not strongly oblique *Natica*, pp. 36–37.
- Body whorl strongly oblique and less inflated *Albula* (incl. *Polinices*), p. 38.
3. Shell not depressed, columella lip approximately straight, umbilicus present *Eunaticina*, p. 38.
- Shell depressed, columella lip arched, umbilicus rudimentary or absent *Sinum* (= *Sigaretus*), pp. 38–39.

The genus *Natica* is represented at Madras by numerous species which may be distinguished thus.—

1. Callus on inner side of aperture without surface groove, white in colour as a rule 2
- Callus on inner side of aperture divided by a surface groove into anterior and posterior parts, brownish in colour. Shell more or less uniformly coloured (subgenus *Neve-rita*) 10
2. Shell with more or less distinct spiral bands, or almost uniformly coloured 3
- Shell decorated with transverse wavy lines, blotches or spots 5

¹ In Reeve's figure (*Conchologia Iconica* VI, *Rostellaria* pl. iii, fig. 10) it crosses several whorls.

3. Shell small, spiral bands obscure, umbilicus usually more or less filled by callus *N. marochiensis*¹.
 — Shell large, spiral bands conspicuous, umbilicus always open 4
4. Spiral lines uniformly pale, usually somewhat broad; whorls of spire not inflated *N. albula*².
 — Spiral lines white, interrupted by dark brownish spots, usually narrower. Whorls of spire inflated *N. ala-papilionis* (fig. 5 g).
5. Shell closely covered with lines of dots *N. tigrina*.
 — Shell decorated with continuous wavy lines or with blotches 6
6. Callus white 7
 — Callus brown *N. traillii*.
7. Shell with irregular lines, sometimes confluent, but without blotches 8
 — Shell blotched *N. pulicaris*.
8. Umbilicus semicircular or γ -shaped, extending round strong callus at base of columella 9
 — Umbilicus open only in front of columella callus. Markings dark brown, densely massed in a broad band in middle of body whorl, sparser above and below *N. raynoldiana*.
9. Body whorl bearing four white bands with broad and mostly more or less \angle -shaped markings, separated by three bands of finer and denser markings *N. picta*.
 — Shell marked with continuous transpiral wavy lines *N. lineata*.
10. Anterior part of callus if anything a little larger than posterior part, leaving large umbilicus fully exposed. Spire much depressed *N. lamarckii*.
 — Posterior part of callus much larger than anterior part and fused throughout its length with body whorl, somewhat obscuring the smaller umbilicus. Spire somewhat less depressed *N. didyma*.

¹ A species often found crawling on the sand at the seaward end of the Ennur backwater.

² This species is somewhat variable in the number and distinctness of the pale bands. The body whorl is usually pale above and below, with a broad dark band between on which are two other pale bands, the upper one ill-defined below. The upper, and more rarely also the lower, of these two pale bands may, however, be absent, and one specimen in Mr. Crichton's collection lacks also the pale region immediately below the suture. This specimen is thus uniformly dark except on the base and it is interesting to find that the columella callus is also dark instead of white. The callus sometimes shows an anterior lobe extending upwards into the umbilicus but is usually without it.

The subgenus *Neverita* (*Natica lamarckii* and *didymia*) seems to be to some extent intermediate between *Natica*, *s. str.*, and the genus *Albula*, the Madras species of which may be identified thus.—

1. Callus at base of columella white and very broad 2
- Callus at base of columella dark brown, usually narrower 3
2. Umbilicus completely closed by callus *A. mamilla* (fig. 5 h).
- Umbilicus very large, partly occupied by columella, base of which forms a more or less semicircular projection of callus *A. pes-elephantae*.
3. Shell brownish with pale band bordering suture and a broader one lower down *A. melanostoma*.
- Shell white with three spiral lines of brown spots *A. melanostomoides*.

The Madras species of *Eunaticina* are as follows.—

1. Shape as in *Natica*, suture in broad hollow, a few spiral grooves below it, rest of surface unsculptured, callus rudimentary *E. pomatiella*.
- Body whorl more oblique, suture scarcely sunk, surface spirally grooved throughout 2
2. Body whorl only slightly oblique, callus strongly developed *E. coarctata*.
- Body whorl strongly oblique, callus weak *E. papilla*.

Eunaticina papilla leads on to the genus *Sinum*, the Madras species of which are as follows.—

1. Spire exsert, visible in profile, situated not far from outer end of suture, spirals well developed, not much wrinkled. 2
- Spire completely flattened, not visible in profile, more centrally situated, shell practically flat 4
2. Shell not much depressed, somewhat round with almost circular aperture, about twice as broad as tall as seen from behind *S. neritoideum* (fig. 5 i & 6 a).
- Shell more depressed and longer with more elongate aperture, at least two and a half times as broad as tall as seen from behind 3

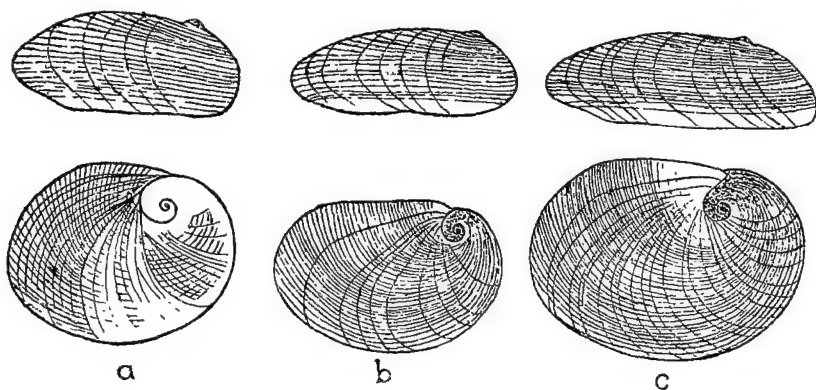


FIG. 6.

a. *Sinum neritoideum*.b. *Sinum cuvierianum*.
From behind and from above.c. *Sinum delessertii*.

3. Shell about two and a half times as broad as tall, apex somewhat near side margin of body whorl *S. cuvierianum* (fig. 6 b).
 — Shell still flatter, about three times as broad as tall, apex somewhat less excentric *S. delessertii* (fig. 6 c).
 4. Spirals wrinkled, well developed *S. haliotideum*.
 — Spirals obsolete or absent *S. planulatum*.

Cowries (Cypraeidae).

Adult shell inrolled, solid, polished, with spire hidden and with long narrow aperture usually toothed on both sides. Immature specimens thin and fragile, with spire exposed and outer lip neither inrolled nor toothed. Mantle capable of being extended over surface of shell, anus posterior, short proboscis and anterior siphon present.

This well known family of beautiful shells has been split up by specialists into a number of genera and subgenera, based largely on the nature of the radula and thus impossible for most amateur shell collectors to follow. It therefore seems best here to distinguish only three genera, *Erato* a minute shell in which the spire is external even in the adult, *Volva* in which both lips of the aperture are smooth and both ends of the shell long and tapering, and *Cypraea* defined in its original sense, i.e., so as to include all species of true cowries. The genera to which the Madras species of *Cypraea* are now referred by specialists are, however, indicated in the list on page 97.

A single worn whitish specimen in Mr. Crichton's collection seems to belong to the genus *Erato*.

The genus *Volva* is represented by a single species, *V. sowerbyana* (fig. 5 j), which is also very rare near Madras. It is of a somewhat purplish colour with a whitish band in the middle.¹

Of *Cypraea* at least eleven species have been found, though several are represented by only a single specimen (or even fragment) in the collection of Mr. Crichton. When fresh they may be distinguished from one another with the aid of the following key. But often the surface layer gets worn off in dead shells that have been rolled about in the sea, and in that case, though otherwise in good condition, they sometimes show quite a different colour pattern. If the surface layer has not completely disappeared the identity of such shells is usually sufficiently apparent, but often the species of more strongly worn shells can only be determined by comparison with specimens worn to a less degree.

- | | | | | | | |
|---|-----|-----|-----|-----|--|---|
| 1. Colour uniformly white or yellow | ... | ... | ... | ... | <i>C. moneta</i> (fig. 5 ^k). | |
| — Colour darker or more varied | ... | ... | ... | ... | | 2 |
| 2. Shell marked with small and closely set pale dots | ... | ... | ... | ... | | 3 |
| — Pale markings either large white spots or irregular or absent | ... | ... | ... | ... | | 5 |
| 3. Dots white, many of them with a tiny black centre | ... | ... | ... | ... | <i>C. ocellata</i> . | |
| — Dots uniformly pale | ... | ... | ... | ... | | 4 |
| 4. Dots minute, margin of shell white, usually with callus thickening crossed on either side by a broad band of brown | ... | ... | ... | ... | <i>C. erosa</i> . | |
| — Dots less minute, margin spotted and flecked with dark brown but without brown band | ... | ... | ... | ... | <i>C. lamarckii</i> , ² | |
| 5. Shell dark brown with two indistinct transverse bands of a somewhat lighter tint, pale markings absent | ... | ... | ... | ... | <i>C. onyx</i> . | |
| — Shell not as above | ... | ... | ... | ... | | 6 |
| 6. Shell of a bluish or greenish grey colour above, more or less finely mottled with brown markings | ... | ... | ... | ... | | 7 |
| — Shell brown with whitish markings | ... | ... | ... | ... | | 9 |

¹ Concerning the colour of the animal see Crichton, *Journ. Bombay, Nat. Hist. Soc.* XLII, 1941, p. 332.

² Mr. Winckworth thinks that *C. caput-serpentis*, a species common in the Pamban area, may also occur as he has obtained a specimen from a fisherman at Madras. It is, however, on sale in large numbers at Ramesvaram together with *C. tigris* and other shells. *C. tigris* is imported into Madras for sale to visitors to the beach so *C. caput-serpentis* may not improbably be imported also. Its spots resemble those of *C. lamarckii* but are closer together on a darker brown ground with a broad unspotted dark brown margin on either side, pale in front and behind.

7. Teeth on lips strongly developed and more or less extended as folds across surface, especially strong on outer lip. Shell somewhat elongate; or broadened, especially in middle, by a brown-spotted whitish callus thickening of margin *C. caurica*.
- Shell more or less egg-shaped, without callus thickening margin 8
- 8¹. As seen from above somewhat obliquely from left of shell, anterior canal visible as a slight concavity and posterior canal as an indentation deeper than a semicircle; shell over an inch in length *C. pallida*.
- As seen from above somewhat obliquely from left of shell, anterior canal scarcely visible and posterior canal as an indentation shallower than a semicircle; shell barely three-quarters of an inch in length *C. fimbriata*.
9. Shell only about an inch long, of a somewhat yellowish brown tint, ornamented with sharply defined white spots which tend to be somewhat larger above than below but are otherwise alike *C. cribraria*.
- Shell much larger 10
10. Shell ornamented with more or less confluent whitish spots of various sizes mixed together, teeth colourless. Rare *C. nivosa*.
- Shell with more irregular markings, teeth brown. Common. *C. arabica*.
- Living specimens of *C. pallida* and *C. arabica*, especially the latter, are not uncommon in the harbour, *C. arabica* at least occurring also among the concrete blocks protecting it in Rayapuram Bay. Two forms of *C. arabica* can be distinguished though they merge imperceptibly into one another: *C. arabica*, s. str., in which the shell is comparatively low and tends to be more elongate, and var. *histris*, in which it is more abruptly elevated behind and tends to be of stouter build throughout with a somewhat more open network of markings.²

Helmet Shells (Cassididae).

Shell inflated, with short spire and elongated aperture. Operculum elongate, horny. Foot large. Proboscis and siphon long.

¹ Mr. Crichton informs me that in the only specimen of *C. fimbriata* that he has taken alive the animal was of a red colour reminiscent of freshly cut raw meat, but that that of *C. pallida* is a pale whitish grey.

² See also Crichton, *Journ. Bombay Nat. Hist. Soc.* XLII, 1941, p. 338.

Four species of the genus *Phalium* are not uncommon at Madras. *P. bisulcatum* and *P. canaliculatum* seem to be finely spirally striate throughout life, but *P. areola* (fig. 7 a) and *P. glaucum* which grow to a larger size, though similarly striate till about half grown, have

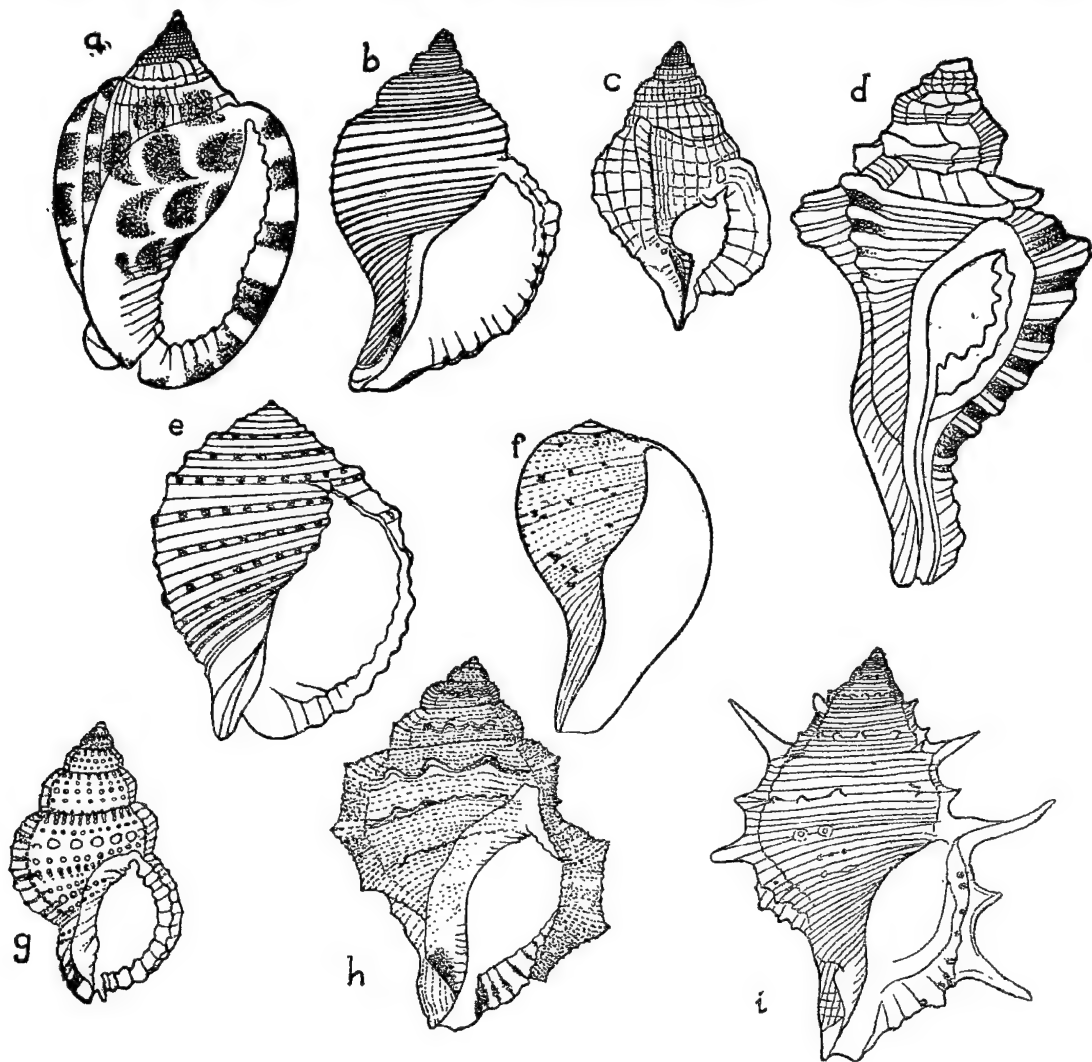


FIG. 7.

- a. *Phalium areola*.
- b. *Cymatium cingulatum*.
- c. *Distorsio cancellina*.
- d. *Cymatium rhinoceros*.
- e. *Tonna dolium*.

- f. *Ficus ficus*.
- g. *Bursa granularis*.
- h. *Bursa crumena*.
- i. *Bursa spinosa*.

the final whorls smooth, completely hiding the striate portions. Fresh specimens of the first three species, and sometimes of young examples of the fourth, are decorated with four or five spirals of squarish bright brown spots, particularly large and close together in *P. areola*, which are absent in larger specimens of *P. glaucum*. In *P. bisulcatum* the spiral striae and the teeth inside the outer lip of the aperture are weaker and more numerous than in *P. canaliculatum*, which differs from all the others in having the suture sunk in a deep groove. *P. areola* is distinguished by the presence of varices¹, and *P. glaucum* by the strongly toothed anterior end of the outer margin of the outer lip, as well as by a spiral line of teeth a little below the suture.

Tritons (Cymatiidae = Tritonidae).

Shell thick, almost always with well developed spire and with horny covering when fresh, sometimes with strong growth of bristles along edges of varices. Varices almost always present except in very young shells, sometimes toothed, more rarely spired. Aperture with anterior but no posterior canal, lips usually thickened, columella mostly with numerous folds.

Three genera are represented, *Gyrineum*, *Cymatium* and *Distorsio*.

In the genus *Gyrineum* the shell is decorated throughout with spiral lines of rounded tubercles much as in *Cerithidea*. In *Cymatium*, the most abundant genus, the sculpture is more varied, but is not of this particular type. *Distorsio* is distinguished from *Cymatium* by the presence in the adult of a callus of remarkable breadth on the columella side of the aperture.

Gyrineum is represented by a single species, *G. natator*, with one pair of varices to each whorl. These form a pair of almost continuous low rounded ridges, one on each side of the shell. The teeth on the inner side of the outer lip are small and widely separated. It is recorded by Crichton as abundant in the harbour especially during the early months of the year (*Journ. Bombay Nat. Hist. Soc.* XLII, 1941, pp. 336-337).

The Madras species of *Cymatium* may be characterised thus:—

- | | | | | |
|--|-----|-----|-----|----------------------------------|
| 1. Spire elevated, anterior canal shorter | ... | ... | ... | 2 |
| — Spire depressed, anterior process very long and slender. | | | | |
| Callus on columella side of aperture almost as strongly developed as in genus <i>Distorsio</i> | ... | ... | ... | <i>C. retusum</i> . |
| 2. Shell more or less uniformly spirally grooved, without conspicuous varices or other transpiral ridges | ... | ... | | <i>C. cingulatum</i> (fig. 7 b). |
| — Varices strong except in very small shells, other transpiral ridges usually also conspicuous | ... | ... | ... | 3 |

¹ A single but very strongly developed varix is also present in a specimen of *P. canaliculatum* presented to the Museum by Mr. Crichton, and Mr. Winckworth reports one or two varices as not uncommon in adult specimens of *P. glaucum*.

- | | | | | | | | | |
|---|-----|-----|-----|-----|-----|-----|-----|----------------------------------|
| 3. Varices well developed, but other transpiral ridges weak or absent | ... | ... | ... | ... | ... | ... | ... | <i>C. pileare.</i> |
| — Additional transpiral ridges also developed | ... | ... | | | | | | 4 |
| 4. Somewhat large shells with their additional transpiral ridges very large and irregular-looking when well grown. | | | | | | | | 5 |
| — Smaller shells with additional transpiral ridges small and regular | ... | ... | ... | ... | ... | ... | ... | 6 |
| 5. Spiral striations on shell somewhat weak especially between the transpiral ridges, callus on columella side of aperture weak and ill defined, aperture somewhat elongated | ... | | | | | | | <i>C. rhinoceros</i> (fig. 7 d). |
| — Spiral striations on shell much stronger, callus on columella side of aperture well developed and sharply defined, aperture more constricted and rounder than is usual in preceding species | ... | ... | ... | ... | ... | ... | ... | <i>C. chlorostomum.</i> |
| 6. Suture sunk in a vertical-sided groove, anterior canal elongate | ... | ... | ... | ... | ... | ... | ... | <i>C. caudatum.</i> |
| — Suture not sunk in a groove, spiral striations delicately beaded when seen under lens, anterior canal short | ... | | | | | | | <i>C. labiosum.</i> |

The genus *Distorsio* is represented by a single species, *D. cancellina* (fig. 7 c). It can be distinguished from the above mentioned species of *Cymatium* in all stages by its reticulate sculpture with rectangular (usually almost square) mesh, and when of sufficient size by its remarkably broad callus expansion on the columella side of the aperture and by its thin and sharp-edged outer lip and varices.

Purse Shells (Bursidae).

This family differs from the last chiefly in the presence of a posterior as well as an anterior canal in the margin of the aperture, but this character is not (? always) present in very young shells.

The genus *Bursa* alone is found at Madras, the species being as follows.—

- | | | | | | |
|--|-----|-----|-----|-----|-------------------|
| 1. Varices less than 2 to each whorl, not forming continuous lines, texture of shell coarse | ... | ... | ... | ... | <i>B. rubeta.</i> |
| — Varices 2 to each whorl, consequently forming 2 more or less continuous lines, one on each side of shell | ... | ... | | | 2 |
| 2. Posterior canal unspined (fig. 7 h) | ... | ... | ... | ... | 3 |
| — Posterior canal spined (fig. 7 i) | ... | ... | ... | ... | 5 |

3. Surface decorated with spiral lines of tubercles as in
Gyrineum *B. granularis*¹ (fig. 7 g).
- Surface decorated with more or less fine and somewhat
granular spiral ridges 4
4. Edges of varices rounded, entirely toothless, columella side
of posterior canal with two or three folds so strong as to
suggest a row of teeth, spire rather taller than usual in
proportion to its width *B. margaritula*.
- Edges of varices sharper, with at least one distinct tooth
(varices double in large shells), columella side of posterior
canal without conspicuous folds *B. crumena* (fig. 7 h).
5. Spines on varices short, spiral ridges granulate and very
finely transversely striate giving a roughened appearance
to surface *B. rana*.
- Spines on varices long, surface with spiral markings but
smooth in general appearance 6
6. Shell not conspicuously flattened, lines of teeth between
varices more or less evenly spaced, spines at ends of vari-
ces long, that beside posterior canal usually directed
more or less backwards *B. spinosa* (fig. 7 i).
- Shell conspicuously flattened, only about two lines of teeth
between varices with a broad flat space between them,
spines at ends of varices still longer, that beside posterior
canal usually directed more or less directly outwards *B. suensonii*.

The resemblance between *B. granularis* and *Gyrineum natator* is extraordinarily close. In addition to the presence of the posterior canal the former differs from the latter in having larger and more numerous teeth on the inner side of the outer lip, and in having not one but two rows of small tubercles below the suture, those of the row next the suture being transversely elongate.

Tun Shells (Tonnidae = Doliidae).

Shell inflated, with spiral sculpture, low spire, very large body whorl and aperture, without varices. Operculum absent. Foot very large. Siphon long.

Four species occur, all belonging to the genus *Tonna*. The commonest species, *T. dolum* (fig. 7 e), is a large and somewhat fragile shell in which the principal ridges are marked with alternating patches of white and brown, the broad spaces between these ridges bearing

¹ Mr. Crichton has a single specimen, unfortunately not in perfect condition, of a somewhat taller form that is probably distinct and may possibly, I think, be *B. candidata* (Lamarck) or *B. semigranosa* (Lamarck).

smaller and less prominent ridges more or less close together and unadorned with colour. It is sometimes found alive in the Ennur backwater on the inner side of the bar shortly after this closes. The other three species are thicker and stronger. In *T. cumingii* the shell is of a brownish colour with whitish and darker brown markings (which may, however, be obscure), the ridges being all close together. In *T. fasciata* the colour is whitish with four or five spiral bands of brown which tend to fade out before reaching the lip. The ridges are not quite so close together, the three immediately below the suture being separated by two grooves, the uppermost of which is slightly broader than the ribs on either side of it. The outer lip is very slightly thickened and toothed, with folds immediately inside. The fourth species, *T. pomum*, of which only a single specimen has yet been found, belongs to the subgenus *Quimalea* in which the aperture is narrower, the outer lip is greatly thickened and strongly toothed within, and the columella has several folds. It is a brownish shell, blotched with white on the raised spiral bands which are broad and flat but not very close together.

Fig Shells (Ficidae = Pirulidae).

Shell long and pear-shaped with very large body whorl and aperture, very low spire, and spiral or reticulate sculpture, usually fine. Varices and operculum absent. Foot very large with projecting anterior angles. Siphon long.

Ficus ficus (fig. 7 f) is common but, as it is somewhat fragile, perfect specimens are not always easy to procure. The surface is finely reticulate as seen under a lens, but the spiral markings are those most easily seen with the naked eye. It is usually found in a more or less bleached condition, but fresh specimens are brownish in colour with narrow interrupted lines of darker brown and a few broader whitish lines interrupted with larger patches of a similar dark brown. The degree of depression of the spire and of elongation of the anterior end of the shell are somewhat variable.

Ficus ficoides is much rarer. It closely resembles *F. ficus* but its sculpture is clearly reticulate to the naked eye, the transverse ridges often being almost as strong as the spiral ones.

Mr. Crichton has also two specimens of *F. gracilis*, somewhat broader than the few that Mr. Winckworth has seen from other localities, but otherwise identical. It has a somewhat more elevated spire than the other two species and is somewhat more attenuated behind. It attains a larger size than the other two and has broader spiral bands well separated and sometimes with a fine spiral line crossed by transpiral ones in the interstices.

STENOGLOSSA.

Venus' Combs, Purples, etc. (Muricidae).

Shells variable, often with varices bearing long spines or stout foliaceous tubercles, columella mostly without folds, anterior canal often long and more or less closed. Foot usually large. Proboscis long. Mantle with glands for the secretion of purple.

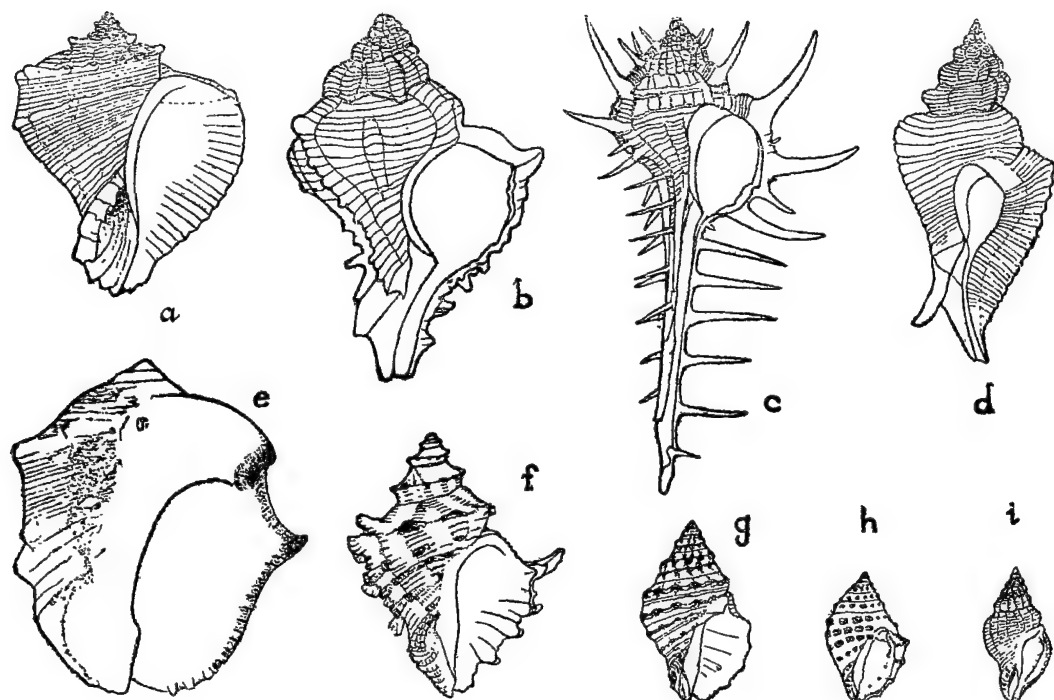


FIG. 8.

- a. *Rapana bulbosa*.
- b. *Murex virgineus*.
- c. *Murex tribulus*.
- d. *Murex pinnatus*.
- e. *Thais bufo* var. *callosa*.

- f. *Thais rugosa*.
- g. *Thais tissoti*.
- h. *Thais granulata*.
- i. *Thais margariticola* (immature).

It is impossible to find any precise definition to cover all shells of this family. Those with well developed varices may sometimes get confused with tritons, from which they can usually be most readily distinguished by the smoother columella and often by the more intensely ornate processes of the varices. But the most fundamental differences are those of the two different orders to which the families belong, and these concern the animal, not its shell. Species without varices may be similarly confused with certain species of the next three families from which they can best be distinguished by the coarser texture of the shell surface, which appears scaly under a lens, at least beside the growing margin of the aperture.

Four genera are known from Madras: *Murex*, *Rapana*, *Thais* and *Drupa* (incl. *Morula*). As, however, the Madras species of the two last grade completely into one another in their shell characters and can only be distinguished with certainty by the radula, which

cannot be obtained from dry shells washed up on the beach, they are treated here as a single genus *Thais*. The Madras genera may then be defined thus :—

- | | | | | |
|---|-----|-----------------|----------------|---|
| 1. Anterior canal long and narrow, varices present | ... | ... | <i>Murex</i> . | |
| — Anterior canal shorter and more open, varices mostly absent | ... | ... | ... | 2 |
| 2. Body whorl greatly enlarged, spire comparatively small | ... | <i>Rapana</i> . | | |
| — Body whorl and spire normal | ... | ... | <i>Thais</i> . | |

The genus *Rapana* is represented by a single species, *R. bulbosa*¹ (fig. 8a) a somewhat large shell commonly decorated with a spiral line of small processes, the spire low and the anterior part somewhat produced but made wide by the broadly open canal and very large umbilicus. The other two genera are each represented by more numerous species.

The Madras species of *Murex* mostly possess processes on the varices. But these are apt to be broken or worn down in specimens that have been carried from a distance by currents, and in young specimens they may never have been fully developed. Such points should be borne in mind when using the following key :—

- | | | | | |
|---|-----|------------------------|--------------------------------------|---|
| 1. Processes on varices more or less distinctly foliaceous, comparatively short and stout | ... | ... | ... | 2 |
| — Processes on varices either absent or long and spiniform | ... | | | 7 |
| 2. Shell small, its last varix greatly flattened and expanded with numerous small close-set flattened processes | ... | <i>M. secundus</i> . | | |
| — Shell large with all varices foliaceous and more or less alike | ... | | | 3 |
| 3. Two ridges or lines of tubercles between each pair of varices | ... | ... | ... | 4 |
| — One ridge between each pair of varices | ... | ... | ... | 5 |
| 4. Spire comparatively short and broad, shell often large | ... | <i>M. incarnatus</i> . | | |
| — Spire more slender, shell somewhat smaller | ... | ... | <i>M. torrefactus</i> ² . | |
| 5. Processes on varices large and intensely foliaceous, crowded together, surface layer of shell black | ... | ... | <i>M. adustus</i> ³ . | |
| — Processes on varices smaller and mostly somewhat obscurely foliaceous, widely spaced, shell pale brownish, often with a spiral band of darker brown a little below the widest part. Length of anterior canal variable | ... | ... | ... | 6 |

¹ See p. 98, footnote 2.

² *M. torrefactus* has a larger aperture than *M. adustus* in proportion to the size of the shell, in addition to differing as noted under group 3 and being browner in colour. In general form the two are much alike.

6. Shell not particularly thick and heavy, varices moderately developed with somewhat numerous and well developed processes *M. virgineus* (fig. 8 b).
- Shell very thick and heavy, varices forming stout rounded ridges, their processes few and poorly developed *M. virgineus* var. *ponderosa*.
7. Varices forming thin and greatly elevated crests, without definite processes, columella and umbilicus bifid *M. pinnatus* (fig. 8 d).
- Columella and umbilicus simple, produced to form a slender process enclosing anterior canal which is longer than spire 8
8. Varices bearing long slender spines *M. tribulus*¹ (fig. 8 c).
- Varices without definite processes *M. haustellum*.

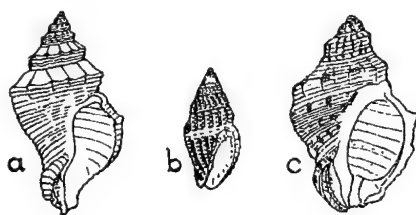


FIG. 9.

a. *Thais kochiana*. b. *Engina zea*. c. *Thais* sp. nr. *tissoti*.

The genus *Thais*, as defined above to include *Drupa*, seems to be composed of a number of species that have been derived from a single stock represented to-day by *T. tissoti* (fig. 8 g), in which the main characteristics of all the others are present in a more or less rudimentary condition. From this stock three stems diverge. One of these stems consists of a single species, *T. kochiana* (fig. 9 a), perhaps leading towards the genera *Rapana* and *Murex*. At the base of one of the other two stems stands an undetermined form referred to below as *T. sp. nr. tissoti* (fig. 9 c), followed by *T. rugosa* (fig. 8 f) from which diverge *T. gemmulata* followed by *T. intermedia*, and *T. carinifera* followed by *T. bufo* (fig. 8 e) and *T. rudolphi*. At the base

¹ The common form in the neighbourhood of Madras is *M. tribulus* s. str., but its variety *trapa*, also occurs. In the typical form there is a row of small spines arising beside the three rows of long ones or at least beside the last of them, there is at most a low tooth below the middle of the outer lip which is somewhat more strongly arched, and the spines or the anterior process are numerous—usually about 7. In var. *trapa* the additional row of spines is rudimentary or absent, there is a well developed broad flattened tooth below the middle of the outer lip which is somewhat less strongly arched, and the spines on the anterior process are fewer—usually about 4. But the two forms do not seem to me to be sufficiently well separated to rank as different species.

of the third stem stands *T. bimucronata* (fig. 10 d) followed by *T. subnodulosa* from which diverge *T. anaxares* and *T. granulata* in one direction and *T. margariticola* (fig. 8 i) followed by its variety *heptagonalis* in another. It will be noticed that the shells in the group with *T. rugosa* at its base are distinctly larger than those of the group with *T. bimucronata* at its base, and that each of these groups includes a subgroup characterised by the special development of tubercles on the shell, the species with the strongest tubercles on the outer surface having in both cases also developed particularly strong teeth within the aperture. It may further be noted that in species where these teeth are not very strong they tend to disappear during certain phases of growth and are therefore not to be regarded as a reliable character for purposes of identification.

The following key to the species of *Thais* (incl. *Drupa*) is based upon the grouping outlined above.—

- | | | | | | | |
|--|-----|-----|-----|-----|-----|---|
| 1. Broadly rounded transpiral ribs more strongly developed than spiral sculpture, spirally arranged tubercles absent, shell not very large | ... | ... | ... | ... | ... | 2 |
| — Transpiral ribs indistinct or absent, spiral rows of tubercles often present | ... | ... | ... | ... | ... | 3 |
| 2. Main spiral ridges brown with whitish interstices, transpiral ribs more or less strongly shouldered | ... | ... | ... | ... | ... | <i>T. margariticola</i> (fig. 8 i). |
| — Shell whitish, with or without small brown markings, transpiral ribs not strongly shouldered | ... | ... | ... | ... | ... | <i>do. var. heptagonalis</i> ¹ . |
| 3. Smallish shells covered with numerous rounded tubercles arranged in spiral and transpiral lines | ... | ... | ... | ... | ... | 4 |
| — Shells with fewer and more pointed tubercles, or with spiral sculpture which may or may not be markedly tubercular | ... | ... | ... | ... | ... | 5 |
| 4. Tubercles, which arise from a pale ground, uniformly blackish, with no marked difference in form between alternate rows | ... | ... | ... | ... | ... | <i>T. granulata</i> (fig. 8 h). |
| — Tubercles of alternate spirals broad and narrow respectively, broad spirals greenish grey, narrow spirals browner, pale ground absent | ... | ... | ... | ... | ... | <i>T. anaxares</i> . |

¹ The more I see of this form the less am I inclined to regard it as distinct from *T. margariticola* s. str. with which it forms an unbroken series, the difference between the two extremes often being intensified at the *heptagonalis* end by wear and bleaching. At Madras *T. margariticola* is commonly found alive in the sea, while var. *heptagonalis* is commonly found inhabited by hermit crabs in the backwaters.

-
5. Body whorl with five or six conspicuous spiral ridges, broadly rounded transpiral ribs more or less faintly recognisable 6
 — Body whorl with at most four conspicuous spiral ridges ... 7
6. Principal spiral ridges all markedly elevated on each rib, aperture violet with four teeth within matured outer lip, of which largest is nearest anterior canal *Thais subnodulosa*.
 — Two uppermost of principal spiral ridges more or less angularly elevated on each rib, rest not or scarcely elevated there *T. bimucronata* (fig. 10 d).
7. Shell somewhat small, without well developed processes, its surface marked by spiral ridges with clear grooves between 8
 — Shell somewhat or much larger, with well developed processes; or its surface usually marked by closely approximated flattened spirals¹
8. Anterior canal more prolonged than in any other Madras species of the genus, ridge at shoulder whitish and distinctly undulated, rest of shell brownish, ridges above shoulder more or less obsolete, those below flattened but well separated, none of them markedly outstanding *Thais kochiana* (fig. 9 a)
 — Anterior canal normal, all spiral ridges distinct and more or less convex, ridge at shoulder and another somewhat below it stronger than any others, usually undulated and of multiple composition, two others usually more or less outstanding below them *Thais tissoti* (fig. 8 g).
9. Shell with four prominent spiral ridges (of which the third from the top may be obsolete) or lines of processes ... 10
 — Shell with not more than two prominent spiral ridges or lines of processes 13
-

¹ The latter character only applies to large specimens. In young ones, as in the other species of the genus, adults of which they may equal in size, the smaller spiral ridges are rounded above and more distinctly separated—evidently their primitive form. Such specimens can, however, readily be recognised by their comparative fragility. In *Thais* sp. nr. *tissoti*, *T. rugosa* and *T. gemmulata* the ridges retain their primitive form, in the very variable *T. carinifera* they may have either form, even in large specimens, but in other species they seem always to be flattened and closely approximated in well grown shells.

10. Processes present on upper two ridges only, or if present on lower two then less prominent on them than are the ridges themselves 11
- All four lines of processes clearly developed, the ridges more or less obsolete 12
11. Shell smallish, columella definitely angular at hind end of anterior canal, processes not very large, absent from third and fourth ridges *Thais sp. nr. tissoti* (fig. 9 c)¹
- Shell larger, columella normal without clear angle, processes strongly developed on first ridge, less so on second, very small on third and fourth *Thais rugosa* (fig. 8 f).
12. Shell orange-yellowish with processes of moderate size, outer lip pale, often tinged with orange, not toothed within *T. gemmulata*.
- Shell brown with processes very large and coarse, outer lip margined within wholly or in part with dark violet, bearing four strong teeth of which smallest is nearest anterior canal *T. intermedia*.
13. Aperture entirely pale within, whorls strongly shouldered and keeled, processes strongly developed, arranged in either or both of two lines, one opposite widest part of aperture, the other above it *T. carinifera*.
- Aperture with dark border within, whorls scarcely shouldered, processes weaker 14
14. Shell very broad, spire low with apex either approximately rectangular or more or less embedded in a large callus, one or two spiral lines of processes usually distinct *T. bufo*² (fig. 8 e).
- Shell somewhat taller with more elevated spire, its apex more acute, processes obsolete *T. rudolphi*.

Most of the above species of *Thais* can be found alive at Madras. *T. tissoti* and *T. rugosa* are abundant among mussels, etc., on wooden piers in the harbour. Fine specimens of *T. bufo* and *T. rudolphi* and of the rarer *T. intermedia* and still rarer *T. gemmulata* live on

¹ Only a few worn specimens of this have been found and Mr. Winckworth doubts their distinctness from *T. tissoti*. The angularity of the columella at the posterior end of the anterior canal seems to me, however, to be a character found in no other Madras species, while the sculpture places it under the second rather than the first of the alternatives in section 7 of the above key.

² The form with spire largely embedded in callus as figured is distinguished as variety *callosa*.

the seaward edge of the group of concrete blocks in the fork of the harbour arm to the east of the harbour entrance, with *T. margaritica*, *T. subnodulosa*, *T. granulata* and the much rarer *T. anaxares* somewhat further back. But *T. bufo* in all stages of growth and *T. granulata*, of which no young have been found, are most abundant on the shorter arm that extends into the sea eastward from near the commencement of the main one. *T. carinifera* and *T. margaritica* var. *heptagonalis* are not uncommonly carried by hermit crabs in the Ennur back-water but neither has been found alive, though Mr. Crichton once got two fresh-looking specimens of *T. carinifera* (also inhabited by hermit crabs) from the harbour. From the fact that bleached and more or less subfossil specimens of this species are abundant in black earth beside the Buckingham Canal towards Mahabalipuram and beside channels draining eastwards into the Pulicat Lake and elsewhere up and down the coast, I conclude that it is a back-water species that was once much commoner and more widely distributed in the neighbourhood of Madras than is the case today. That it is a backwater species receives confirmation from its occurrence in the Chilka Lake in Orissa as recorded by Annandale and Kemp (*Mem. Ind. Mus.* V 4, 1916, pages 343-344). Concerning *T. margaritica* var. *heptagonalis* see above, p. 50, footnote. *T. kochiana* has been collected by Mr. Crichton south of Elliot's Beach from catamarans, but is rare.

Pyrenidae (= Columbelloidea).

Shell not very large, with more or less elevated spire, usually spindle-shaped and somewhat solid. Aperture narrow with short anterior canal, its lip often toothed when not in active growth. Foot large, pointed behind. Tentacles long.

Six species are found, all belonging to the genus *Pyrene*.—

- | | |
|---|-----------------------|
| 1. Transpiral ribs absent | 2 |
| — Transpiral ribs present though sometimes weak | 4 |
| 2. Whorls of spire with two brown spiral lines on a pale ground,
body whorl with one or two additional brown lines,
shell small and slender, somewhat thin | <i>P. flavilinea.</i> |
| — Shell not as above, of a more mottled colour as a rule and
definitely thicker | 3 |
| 3. Shell small and slender, very variable in colour, commonly
transpirally or obliquely barred with brown, with or
without a yellowish line at angle of body whorl | <i>P. puella.</i> |
| — Shell considerably larger and proportionally broader,
whitish with brown markings usually in the form of
lines or lines of dots | <i>P. vulpecula.</i> |

4. Shell comparatively large and stout, whitish decorated with brown *P. terpsichore* (fig. 55 a).
 — Shell very slender; or more or less minute; brownish ... 5
5. Shell comparatively broad, strongly ribbed, with spiral darker and paler bands *P. townsendi*.
 — Shell very slender, ribs fainter 6
6. Shell minute, whorls not inflated, minutely spirally grooved *P. japonica*.
 — Shell larger (about half an inch high), whorls somewhat inflated, spiral grooves scarcely distinguishable except at base, and more widely separated *P. thyraea*.

The two species last mentioned are very different from the others. *P. japonica* was described as the type of a distinct genus *Aesopus* which Thiele regards as probably a section of a subgenus of *Pyrene*. *P. thyraea* belongs to the *Parviterebra* group which Thiele regards as probably a subgenus of *Pyrene*.

F. terpsichore is common in the harbour and among concrete blocks in the corner east of the harbour entrance.

Whelks (Buccinidae).

Shell ovate with more or less oval aperture, columella mostly smooth, sometimes wrinkled, without spiral folds. Foot large, without posterior appendages.

The Madras species may be grouped in four genera, one of which has to be subdivided into two subgenera.—

1. Shell smooth, without ribs or sculpture, decorated with a bold pattern of brown patches on a pale ground¹, apex of aperture constricted by spiral ridge on inner side only *Babylonia*, p. 55.
 — Shell with spiral sculpture and usually ribbed, not coloured as above, apex of aperture constricted on both sides or not at all 2
2. Shell spindle-shaped, ribs weak or absent 3
 — Shell not spindle-shaped, ribs more or less well developed ... 4
3. Shell small, aperture also small but with relatively large and well developed apical notch *Engina*, p. 55.
 — Shell somewhat larger, aperture with apical notch absent or relatively small *Cantharus* (Pollia), p. 56.

¹ A similar bold pattern of brown on a pale ground is found in certain helmet shells.

4. Shell somewhat large; anterior canal broadly open, short and more or less straight; aperture evenly rounded above *Cantharus* (s. str.), p. 56.
- Shell much smaller, its anterior canal oblique, narrow and somewhat elongate; apex of aperture with or without a relatively small constriction *Nassaria*, p. 56.

A single small unidentified shell in Mr. Crichton's collection probably belongs to a sixth genus intermediate between *Cantharus* and *Nassaria*, resembling the latter (especially *N. suturalis*) in size and general appearance, but having the anterior canal of the former.

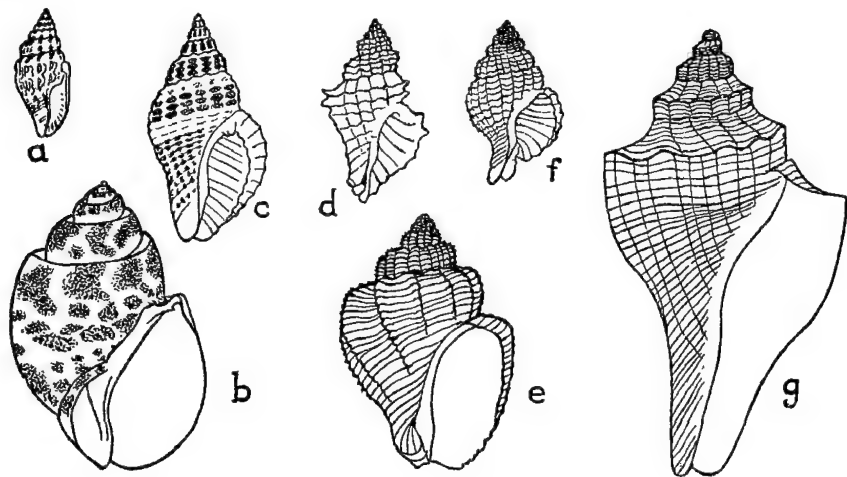


FIG. 10.

- a. *Pyrene terpsichore*.
 b. *Babylonia spirata*.
 c. *Cantharus* (*Pollia*) *proteus*.
 d. *Thais bimucronata*.

- e. *Cantharus* (s. str.) *tranquebaricus*.
 f. *Nassaria nivea*.
 g. *Hemifusus pugilinus*.

Two species of *Babylonia*¹ occur, *B. spirata* (fig. 10 b), in which the suture is sunk in a broad groove, and *B. zeylanica* in which it is not and in which the spire is more strongly elevated and the umbilicus toothed on its outer side. In both species the umbilicus is open in all young specimens; but it is commonly closed by a stout callus in fully grown *B. spirata*.

There are two species of *Engina* to be found, but the only one that is at all common is *E. zea* (fig. 9 b), which lives in the harbour in company with *Pyrene terpsichore* and closely resembles it in general appearance till the brown periostracum is removed. It has low,

¹ Concerning two colour varieties of *B. spirata*, and the colour of *B. zeylanica* in life, see Crichton, *Journ. Bombay Nat. Hist. Soc.* XLII, 1941, p. 334.

tuberculate ribs, the tubercles forming spiral lines as well as transpiral ribs. The tubercles tend to be some yellowish brown, some whitish, on a dark ground, and two rows of them usually form a more or less distinct whitish band extending round the body whorl from the top of the aperture. But though the general colouration seems fairly constant the distribution of the three colours is less so and may be more irregularly mottled. The second species, which is represented by only two specimens in Mr. Crichton's collection, is of a pale brownish colour and lightly ribbed but not tuberculate and has the anterior canal unusually elongate for a Buccinid as it is also in *Nassaria*, but in this *Pyrene* it is open and practically straight.

In the genus *Cantharus* the subgenus *Pollia* is intermediate both in form and in size between *Engina* and *Cantharus* (*s. str.*). It is represented by two species, *C. (P.) undosus* and *C. (P.) proteus* (fig. 10 c). *C. undosus*, which lives among concrete blocks in the corner east of the harbour entrance, is ornamented with a series of blackish spiral ridges with white grooves between them, both being obscured by a thick brown periostracum in life, and is entirely without ribs except near the apex where the ridges are broken. *C. (P.) proteus* has the spiral ridges, which in it are composed each of a group of finer ridges, similarly broken throughout so that they come to form a series of low transpiral ribs. It is brownish in colour with a more or less distinct pale spiral band extending round the body whorl from behind the lip to the top of the aperture and sometimes continuing upwards immediately above or on both sides of the suture.

The Madras species of *Cantharus*, *s. str.*, may be separated thus.—

- | | | | |
|--|-----|-----|--------------------------------------|
| 1. Spire with three strong spiral ridges on each whorl | ... | ... | <i>C. spiralis.</i> |
| — Spiral ridges weaker and more numerous | ... | ... | 2 |
| 2. Inner lip black, upper part of whorls more or less angular in profile, spiral sculpture somewhat strong | ... | ... | <i>C. melanostoma.</i> |
| — Inner lip white or orange, whorls usually more rounded in profile, sculpture delicate | ... | ... | <i>C. tranquebaricus</i> (fig. 10 e) |

Mr. Crichton's collection contains a single specimen of a shell with brownish inner lip and sculpture intermediate between that of *C. melanostoma* and *C. tranquebaricus*. Whether it is a hybrid, or should be regarded as a variety of one of these or as a distinct species, it seems impossible to say without further evidence. But the fact that it is the most solid specimen of the genus collected suggests that it may be distinct.

The genus *Nassaria* is represented by two species, *N. nivea* (fig. 10 f) in which the spire is scarcely taller than broad and the aperture large and oval, and *N. suturalis* with somewhat slender spire and smaller and rounder aperture with apical notch.

Volemidae (= Galeodidae)¹.

Shell of moderate or large size, pear or spindle-shaped, spire never very high, whorls usually with a toothed shoulder ridge, anterior canal open, columella without folds, operculum with nucleus at anterior end. Foot large. Proboscis long.

Hemifusus pugilinus (fig. 10 g) is one of the most massive shells found on the Madras beach.

Nassidae.

Shell with short anterior canal, and truncate and often callus columella. Operculum horny, often with toothed margin. Foot large, often with a pair of posterior appendages. Siphon long.

The Madras genera may be separated thus.—

1. Aperture somewhat narrow, with well developed posterior canal in form of slit between outer lip and body whorl, and anterior canal defined on outer side by small fold in margin of lip, no tooth or callus on upper part of columella lip *Cyllene*, p. 57.
- Aperture broader, posterior canal not as above, sometimes rudimentary 2
2. Anterior canal rudimentary, being widely open, its outer side not defined by any fold or ridge; columella lip without tooth, callus weak or absent *Bullia*, p. 58.
- Anterior canal less widely open, its outer side defined either by a ridge or by a fold in margin of lip; aperture in well developed specimens with either a thick callus, or a strong tooth² on upper part of columella lip, or both 3
3. Operculum with terminal or subterminal nucleus, margin often serrate *Nassa*, p. 59.
- Operculum with nucleus beside inner margin, margin not serrate *Pygmaeonassa*, p. 62.

The genus *Cyllene* is represented only by one smallish species, *C. fuscata* (fig. 11 f), with deep body whorl and small but acutely pointed conical spire, the whorls (excluding those of the protoconch) shouldered, lightly ribbed throughout and spirally striate above the shoulder and at base of body whorl, whitish or brownish in colour, often mottled.

¹ Galeodidae being a particularly well known family of Arachnida (Order Solifugae), the name Volemidae seems preferable, and as *Galeodes* is preoccupied the name *Volema* Röding, 1798, type *paradisiaca* Röding, should I understand be used for that genus.

² This is perhaps present at some time in all species, but in some (e.g. the common *Nassa jacksoniana* of the backwaters) it appears only in the most fully matured shells, while in others (e.g. *N. bellula*) it is apt to be more or less merged in the callus.

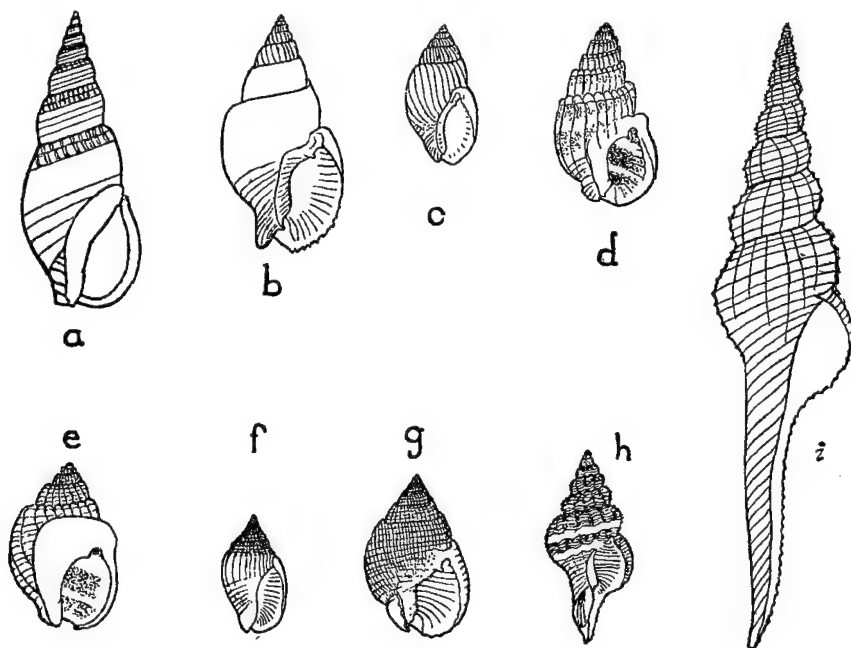


FIG. 11.

a. *Bullia vittata*.b. *Nassa dorsata*.c. *Nassa planocostata*.d. *Nassa costata*.e. *Nassa pulla*.f. *Cyllene fuscata*.g. *Nassa variegata*.h. *Peristernia pulchella*.i. *Fusinus longicauda*.

The Madras species of *Bullia* are larger than most Madras species of *Nassa*, and have a taller and more slender spire. Some of them are common in sand near low tide level where they are often left exposed by a retreating wave, rapidly burrowing again with the aid of the broadly expanded foot, a foot enlarged by the intake of water which has to be driven out again before withdrawal into the shell¹.

The Madras species are as follows.—

1. Suture bordered below by a line of short transpiral ridges,
shell more or less uniformly coloured 2
- Suture bordered below by an unbroken spiral band, shell
ornamented with transpiral brownish lines, base of body
whorl with strong spiral striation *B. tranquebarica*.

¹ See also Crichton, *Journ. Bombay Nat. Hist. Soc.* XLII, 1941, p. 324.

2. Transpiral ridges below suture crossed by at most a faint spiral groove in their upper part, shell bluish grey in colour *B. livida*.

— Transpiral ridges below suture crossed near their middles by strong spiral groove, shell usually somewhat paler in colour. *B. vittata* (fig. 11 a).

The large and varied genus *Nassa* falls, as regards Madras species, into two distinct groups (see section 1 of following key), of which the first resembles *Bullia* in general appearance more closely than it does the second.

1. Transpiral ribs confined to upper part of spire, general surface smooth and even, with or without fine impressed spiral lines, shell moderately large, columella without thick callus 2

— Transpiral ribs more or less distinct (usually strong) throughout, shell usually smaller, sometimes very small, columella often with thick callus 6

2. Suture not sunk in grove, outer lip toothed in front 3

— Suture sunk in groove, shell without colour markings or with faint pale spiral band 5

3. A narrow and more or less tubercular alternately brownish and whitish band present immediately below suture, general surface a somewhat finely mottled darkish grey colour, outer lip not toothed *N. lentiginosa*.¹

— No such band present, general surface with pale brownish markings 4

4. Shell transpirally streaked, outer lip not toothed *N. elegans*.

— Shell more irregularly marbled, outer lip toothed in front *N. ceylonica*.

5. Whorls lightly rounded in profile, spiral sculpture confined to base of body whorl and to one line below suture on ribbed apex, shell light greyish in colour *N. dorsata*² (fig. 11 b).

— Whorls lightly but abruptly angular in profile, straight above and below the angle, which is marked by a fine impressed line with another a little above it and a few fainter ones below, shell light brownish in colour *N. sp. nr. dorsata*.

¹ Mr. Crichton has since collected a single large specimen of *N. olivacea*. Apart from its much larger size it differs from *N. lentiginosa* chiefly in having a pale spiral band a little above the middle of the body whorl continued on to the lower part of the whorls of the spire, and in having the tubercular band immediately below the suture indistinct or absent.

² The young of this species are sculptured almost exactly as in *N. costata*, but their contour is slightly different and the transpiral ridges are somewhat more curved and perhaps a trifle thinner.

- | | |
|--|-------------------------------------|
| 6. Transpiral ribs much more strongly developed than spiral sculpture | 7 |
| — Transpiral ribs much weaker, spiral sculpture usually about as strong as transpiral, sometimes even slightly stronger | 15 |
| 7. Ribs rounded, about equal in breadth to the interspaces between them, often somewhat broader, shells of moderate size | 8 |
| — Ribs crested, much narrower than broad interspaces between them, very small species | 14 |
| 8. Impressed spiral lines strong but practically confined to interstices between ribs, rarely crossing ribs except at extreme base | 9 |
| — Impressed spirals when present extending across ribs, suture as a rule deeper | 10 |
| 9. Callus scarcely developed, impressed spiral lines present in interstices throughout, shell somewhat slender ... | <i>N. planocostata</i> (fig. 11 c). |
| — Callus strongly developed, impressed spiral lines in interstices confined to body whorl, shell slightly stouter ... | <i>N. bellula</i> . |
| 10. Upper ends of ribs narrowly separated from suture by more or less distinct oblique flattened band, impressed spiral lines confined to base and apex, callus absent, shell smallish | <i>N. jacksoniana</i> . |
| — Upper ends of ribs about on a level with suture, shell usually larger | 11 |
| 11. Impressed spiral lines uniformly fine except at base, shell somewhat broad | 12 |
| — Deeply impressed spiral line present a little below suture, cutting off top of each rib as distinct nodule, shell not so broad, callus weak or absent | 13 |
| 12. Callus weak or absent, spiral lines faint, upper ends of ribs not shouldered | <i>N. stolata</i> . |
| — Callus strongly developed, spiral lines more distinct, upper ends of ribs shouldered, ribs towards aperture tending to unite above in groups of two or three in a single shoulder in well grown specimens | <i>N. pulla</i> (fig. 11 e). |

13. Spiral lines obsolete or absent between single deep line
below suture and usual group at base *N. hepatica*.
- Spiral lines well developed throughout, shell somewhat
smaller *N. costata*¹ (fig. 11 d).
14. Callus weak or absent, protoconch depressed with its
apex obtuse-angled; a very small estuarine species ... *N. sumatrana*.
- Callus strongly developed, protoconch more elevated,
its apex acute-angled; a slightly larger marine species ... *N. mangelioides*².
15. Shell almost globular with depressed spire and large callus,
sculpture a lattice of transpiral and fine spiral grooves
enclosing small flat rectangles *N. globosa*.
- Shell of normal form, spiral grooves much broader and
very like the transpiral ones, rows of more or less
distinct tubercles being formed by the intersection of the
grooves between them 16
16. Tubercles weak, row immediately below suture similar to
others, callus weak or absent, shell slightly larger and
more slender *N. sp. nr. gemmulifera*.
- Tubercles very strong, shell smallish 17
17. Shell rather small, moderately slender, uppermost spiral
row of tubercles usually double, especially on lower
whorls of well grown specimens, callus usually weak or
absent, occasionally more strongly developed; colour
whitish, usually with three more or less distinct spiral
bands of brown on body whorl in fresh specimens of
which two lowest bands are apt to be most conspicuous
in young specimens, lowest and most of middle one being
hidden on spire; more rarely with transpiral markings ... *N. gemmulifera*.
- Shell slightly larger and proportionally broader, upper-
most line of tubercles on each whorl single like others,
callus weak or absent; colour whitish, mottled or
transpirally marked with yellowish brown in fresh speci-
mens *N. variegata* (fig. 11 g).

¹ See also above, p. 59, footnote 2.

² Mr. Crichton's collection contains a single specimen closely resembling *N. mangelioides* in size and general appearance, but with the ribs flattened and more numerous, and apparently a somewhat different protoconch. I think it must be distinct, but have not been able to identify it.

Nassa jacksoniana is often very abundant alive in backwaters where *N. planocostata* and *N. bellula* are common on hermit-crabs, never alive. *N. stolata* is another conspicuous backwater hermit-crab species but not nearly so numerous. The last three probably live in the sea, for Mr. Crichton has collected *N. planocostata* south of Elliot's Beach.

The estuarine genus *Pygmaeonassa* is represented by a single species, *P. denegabilis*, a small and somewhat slender greenish brown shell with ribs but without spiral sculpture except at the base.

Knobbed Chanks, Spindle Shells, etc. (Fascioliariidae).

Shell often more or less spindle-shaped, anterior canal strongly developed, often greatly elongated. Columella with few or no folds. Operculum horny with terminal nucleus. Foot short, proboscis very long.

Fusinus longicauda (fig. 11 i)¹, a white shell with tall spire and greatly elongated anterior canal, is moderately common. It is decorated with strong spiral striations, superimposed on transverse rounded ridges towards the apex, and has a greyish periostracum when quite fresh. Much less common is *Fusinus toreuma*, Lamarck, which differs from *F. longicauda* in having a line of broad tubercles at the broadest part of the whorls.

Peristernia pulchella (fig. 11 h) is a much smaller shell, but is occasionally over one and a half inches in height. It is very apt to bleach white but when fresh is brownish with a whitish spiral band, the interior of the aperture being deep pink. Its transverse rounded ridges are stronger and its anterior canal shorter than are those of the other two species, and its spiral ridges are scaly as in *Thais*. Two other species of the genus, both very rare, and with even more strongly scaly spirals, also occur but have not been identified. Both are white when fresh, have a protoconch of only about half the size of the somewhat solid looking protoconch of *P. pulchella*, and have somewhat finer spiral ridges than has that species. One is not unlike that species in general form, but Mr. Crichton's two specimens are both small. The other has more numerous and much narrower ribs and is smaller still. Only a single specimen of this has been found.

Olives (Olividae).

Mostly burrowing snails with highly polished and often handsomely coloured shells with small and often flattened spire, and columella smooth or with shallow grooves or low flattened ridges. Foot broadly disc-shaped with a transverse groove towards the front. A pallial tentacle present behind.

The genera *Ancilla* and *Oliva* are represented. The latter differs from the former in having a well marked posterior canal from which a groove extends along the suture of the spire.

¹ This species is very near but distinct from *F. colus*.

Ancilla ampla is a common slender white shell with somewhat acute and occasionally brownish apex. *A. cinnamomea*, which is much rarer, is yellowish brown when fresh, shorter, stouter and with blunter apex.

The five species of *Oliva* found at Madras may be distinguished from one another thus.—

- | | | | |
|---|-----|-----|-----------------------------------|
| 1. Spire well developed, pale mauve in colour ; anterior part of body whorl pale yellowish brown with dark brown markings, rest mottled greyish or brownish | ... | ... | 2 |
| — Spire relatively smaller ; spire and anterior part of body whorl not very markedly different in colour from rest of shell | ... | ... | 3 |
| 2. Shell somewhat or very stout, body whorl markedly inflated, base of profile of spire at least as long as sides | ... | ... | <i>O. gibbosa</i> ¹ . |
| — Shell slender, body whorl less strongly inflated, profile of spire with base at most as long as sides | ... | ... | <i>O. nebulosa</i> ¹ . |
| 3. Spire conical, colour extraordinarily variable ² | ... | ... | <i>O. ispidula</i> . |
| — Outer whorls of spire flattened | ... | ... | 4 |
| 4. Aperture normal. Shell attaining a comparatively large size, pale brownish in colour, usually with a couple of spiral bands of darker patches | ... | ... | <i>O. oliva</i> (fig. 12 a). |
| — Aperture narrow, almost slit-like. Shell smaller and more variable in colour | ... | ... | <i>O. lepida</i> . |

Mitre Shells (Mitridae).

Shell usually slender, more or less spindle-shaped, with narrow aperture. Columella almost always with folds, anterior canal not sharply defined. Operculum absent.

The Madras species probably belong to two or three different genera, but as they cannot be satisfactorily distinguished without reference to the radula all can best be treated for the purpose of the present paper as belonging to the single genus *Mitra*. They are as follows.—

- | | | | |
|--|-----|-----|----|
| 1. Spiral sculpture at least as strong as transpiral ; or shell not slender | ... | ... | 2 |
| — Transpiral ribs stronger than spiral sculpture, shell slender, adult with tooth on inner side of top of aperture | ... | ... | 12 |

¹ *O. gibbosa* seems to frequent shallower water nearer the shore than does *O. nebulosa*. Concerning this and the feeding habits of the family see Crichton, *Journ. Bombay, Nat. Hist. Soc.* XLII, 1941, p. 324.

² A yellow variety with white interior is particularly striking.

2. Shell at most barely three times as tall as broad, transpiral sculpture usually of little extent or absent 3
- Shell at least three times as tall as broad, transpiral sculpture more extensive 8
3. Shell only about twice as tall as broad, outer lip thick and strongly toothed 4
- Shell fully two and a half times as tall as broad, outer lip thinner, shell brownish 5
4. Sculpture more or less confined to somewhat obscure transpiral ribs on apex and spiral grooves on base, colour brownish *M. robusta* (fig. 12 d).
- Spiral sculpture strongly developed, spirals on spire keeled, those opposite top of aperture broad, those below narrower, intervening spaces crossed by fine grooves, colour reddish with somewhat indefinite whitish band on body whorl *M. cucumerina*.
5. Spire strongly stepped, spiral grooves weak but deeply punctured *M. lacunosa*.
- Spire not clearly stepped 6
6. Aperture extremely narrow, spaces between spiral ridges crossed by distinct transpiral grooves *M. proscissa*.
- Aperture somewhat broader, transpiral grooves represented by little if anything more than punctures 7
7. Shell about two and a half times as tall as broad, upper margin of each whorl usually dark with very small white spots *M. caeligena*.
- Shell about three times as tall as broad, upper margin of each whorl usually clouded with white and dark brown, white as a rule predominating, sometimes entirely pale, rarely dark with white spots *M. marginata*.
8. Shell decorated with strongly keeled spiral ridges, sometimes with faint intermediate ridge between each pair of them, valleys between keels finely transpirally grooved; aperture somewhat longer than spire, columella lip almost straight except for its folds *M. insculpta*.
- Transpiral grooves crossing over spiral ridges, aperture not longer than spire 9

9. Upper whorls of spire with three spiral ridges, lower with more, spiral ridges sharply crested and widely separated, size somewhat large (up to nearly 2 inches high), colour whitish *M. circula* (fig. 12 c).
- Upper whorls of spire with more than three spiral ridges, which are usually broader 10
10. Smallish shells (under 1 inch high) with relatively strong sculpture 11
- Large shells (up to over 2 inches high) with relatively weaker sculpture, especially the numerous spiral ridges which however are lightly crested; colour white with discontinuous transpiral brown bands which are darkest where spiral ridges cross them *M. granatina*.
11. Raised spirals flattened, cut into squares by transpiral grooves of about same strength as spiral ones, shell often clouded with brown above suture *M. pellis-serpentis* e. str.
- Raised spirals more or less distinctly crested, sometimes about as strongly as in *M. circula* but less widely separated, shell whitish *do. var. granata*.
12. Shell with broad whitish band above suture, maximum height about three-quarters of an inch, spiral sculpture between ribs mostly rather strong *M. mica*.
- Shell with more or less distinct and always narrow whitish spiral line near middle of each whorl, and often also a narrow whitish upper border; maximum height nearly twice that of *M. mica*, spiral sculpture between ridges usually somewhat weaker *M. acuminata* (fig. 12 b).

Chanks (Vasidae = Turbinellidae).

Shell solid, usually pear-shaped, with a more or less distinct tuberculate or spiny shoulder ridge, long anterior canal and folded columella.

The sacred chank (*Xancus* = *Turbinella*) has a number of more or less definite forms, perhaps local races, to which various names have been given. The true *Xancus rapa* of the Tuticorin chank beds has a spire the outline of which forms approximately an equilateral triangle, but this form has not been found at Madras. The form characteristic of Madras and the rest of the Coromandel Coast, though possibly only a variety or local race of *X. rapa*,

has been named *X. pyrum* (fig. 12 e) and is a much shorter shell in proportion to its width, with a much less elevated spire. Specimens of *X. dentatus*¹ the form characteristic of Ceylon, are occasionally washed up on the Madras beach though it seems unlikely that they live there. In this the spire is at least equally low but the anterior canal and columella are greatly elongated, while in young specimens the whorls bear a series of rounded ridges which are retained as broad tubercles in the upper whorls of the spire of the adult, though the larval whorls at the apex are smooth as in the other forms.

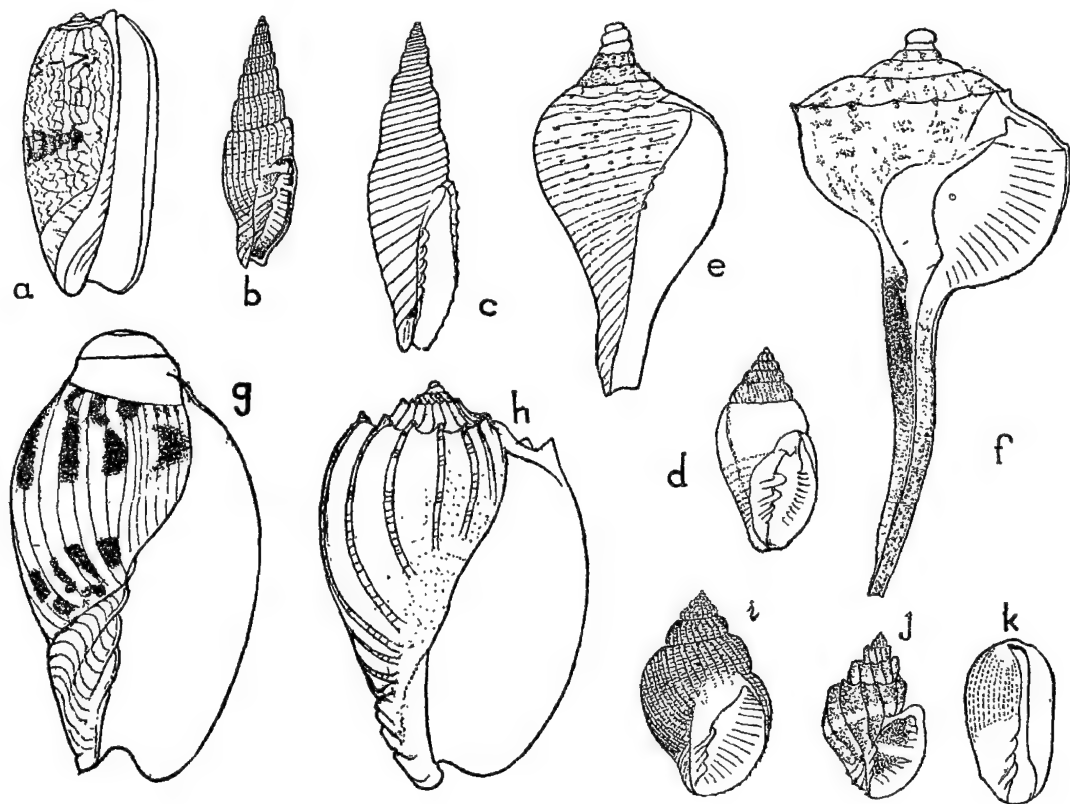


FIG. 12.

- a. *Oliva oliva*.
- b. *Mitra acuminata*.
- c. *Mitra circula*.
- d. *Mitra robusta*.
- e. *Xancus pyrum*.
- f. *Tudicla spirillus*.

- g. *Cymbium melo*, juvenile form with spire exposed.
- h. *Harpa conoidalis*.
- i. *Cancellaria elegans*.
- j. *Cancellaria crispa*.
- k. *Marginella angustata*.

The only other Madras species of this family is *Tudicla spirillus* (fig. 12 f), in which the spire is flattened much as in *Rapana bulbosa* while the anterior canal and columella are

¹ Perhaps best regarded as only a local race of *X. pyrum*.

almost as long and slender as in *Murex haustellum*. The columella bears a projecting plate-like callus with only one very low and broad fold, which is situated beside the commencement of the anterior canal.

Harp Shells (Harpidae).

Shell very strongly ribbed with body whorl inflated and spire small; without operculum, columella folds or defined anterior canal. Foot very large, broad in front, with side lappets, narrowed behind, the hinder end pointed.

Only a single species, *Harpa conoidalis* (fig. 12 h), is found. Concerning the animal and its way of throwing off the hind part of its foot when provoked see Crichton, *Journ. Bombay Nat. Hist. Soc. XLII*, 1941, p. 330.

Melon Shells, etc. (Volutidae).

Shell usually large and smooth. Foot large and broad. Head with a broad fold with the eyes (sometimes absent) on its sides and the small tentacles on its anterior edge. Siphon with two internal appendages. Proboscis short.

The only species found is the Indian Melon Shell, *Cymbium* (= *Melo*) *melo*, with smooth and greatly inflated body whorl almost completely enveloping the spire in well grown specimens. In younger specimens the spire forms a curiously broad and rounded apex. The columella bears strong folds. A young shell is shown in fig. 12 g. The adult is more like a gigantic *Bulla* (fig. 15, 3). Concerning the colour of the animal see Crichton, *Journ. Bombay Nat. Hist. Soc. XLII*, 1941, p. 334.

Cancellariidae.

Shell usually rather small with ribs or latticed sculpture. Columella usually with two or three folds, sometimes smooth. Operculum absent. Proboscis thin in front, thickened behind, provided with a membrane that is narrow in front, broadened behind.

The species of *Cancellaria* found at Madras fall into two groups of very different appearance. The first includes two well marked species, *C. oblonga*, and *C. elegans*, but the second contains various forms so closely related one to another that their separation into varieties and species must be to some extent a matter of opinion. The following key is based on Mr. Crichton's observations confirmed by Mr. Winckworth's identifications.—

- | | |
|---|---|
| 1. Sculpture net-like, umbilicus absent, colour reddish brown. | 2 |
| — Whorls strongly ribbed with spiral lines less marked, suture sunk behind strongly developed shoulder, umbilicus present though sometimes practically closed, colour mostly purplish brown | 4 |
| | |

2. Suture normal, shell not particularly slender, pale spiral bands more or less distinct 3
 — Suture sunk behind strongly developed shoulder, shell slender, uniformly brown except for white teeth one at top of each of occasional and irregularly placed varices. *C. exquisita*.
3. Shell somewhat slender with spire taller than broad and less than 60° at apex *C. oblonga*.
 — Shell somewhat stout with spire not longer than broad and about 60° at apex *C. elegans* (fig. 12 i).
4. Shell somewhat slender, uniformly somewhat darkly coloured apart from paler shoulder, ribs (as in *C. crispa* var. *costifera*) few, widely spaced and scarcely granular. *C. ? tenuis*.
 — Shell broader 5
5. Ribs weak and somewhat numerous, colour more or less uniformly pale even in fresh specimens, umbilicus open. *C. articularis*.
 — Ribs much stronger, colour of fresh specimens greyish or brownish with a white spiral band on body whorl and continued above suture (*C. crispa*) 6
6. Ribs widely spaced, suture deeply sunk behind shoulder, umbilicus particularly large *C. crispa* var. *costifera*.
 — Ribs more numerous, shoulder more or less rectangular, umbilicus mostly smaller 7
7. Ribs towards aperture formed of several thin layers, umbilicus large *C. crispa* var. *lamellosa*.
 — All ribs with a single crest, umbilicus small 8
8. Outer lip with 8-12 (usually 10 or 11) fine ridges inside as in foregoing varieties, umbilicus small *C. crispa*, s. str. (fig. 12 j).
 — Outer lip with 14-16 (usually 16) fine ridges inside, umbilicus still smaller as a rule *C. crispa* var. *histris*.

Marginellidae.

Shell mostly smooth and polished with long and narrow aperture as in the Olividae, but with folds on columella and often with outer lip thickened and spire immersed in body whorl almost as in a cowrie. Operculum absent. Foot large, Siphon somewhat long, without appendages. Mantle spreading over greater part of shell.

Marginella angustata (fig. 12 k) is the commonest species. When adult the spire is completely immersed. Its columella has three large folds with a much smaller one imperfectly separated from the foremost and largest of them. The shell is greyish or slightly brownish in colour, with somewhat indistinct lines or bands which may be either transverse, longitudinal or both.

M. ventricosa is a slightly larger species, more uniformly grey in colour when fresh, with five folds on the columella and with spire exposed.

Minute whitish specimens also occur. These are *M. mazagonica* which has its columella toothed throughout, finely behind, more strongly in front. *M. dens*, of which a single specimen has been collected at Madras by Mr. Crichton, seems to be practically identical in structure but is distinctly larger, being from three-sixteenths to a quarter of an inch long, whereas *M. mazagonica* is barely three-sixteenths of an inch long. Though this difference sounds negligible it is unmistakable when the two species are placed side by side.

TOXOGLOSSA.

Slit-Lips (Turridae=Pleurotomidae).

Upper part of lip with a more or less distinct (sometimes imperceptible) hollow or deep slit, aperture inclined to be long and narrow and spire tall and slender, base more or less tapered, sometimes with anterior canal greatly elongated, columella mostly without folds.

This family is closely related to the next and has been included in it by Thiele, but the shells belonging to each differ so greatly and definitely in form that it seems more convenient to keep the two distinct. Thiele's classification of the genera is based so fundamentally upon the radula that the collector of beach shells cannot expect to make anything of it, since he is unlikely to find the animal nor will he as a rule have the use of a microscope. As the Madras species seem to fall into quite definite groups in accordance with shell characters that can readily be seen, these have been made the basis of the classification used here.

The genus *Daphnella*, as defined by Thiele, is characterized by the network of oblique lines on the protoconch, a feature which—though belonging to the shell and not the radula—can only be seen under a microscope. Three such species occur at Madras, all of them rare, very small, and as yet unidentified. But they are so widely diverse in shell characters that without the clue provided by the protoconch one would never suspect that they belonged to a single genus. They prove, however, to have another character in common, though one difficult to define except in negative terms: the margin to the slit in the lip, though more or less thick, lacks the distinctive characteristics found in the genera *Brachytoma* and *Lienardia* as defined below. In this, as well as in the form and sculpture of two of them, they closely resemble two other species, one of which Mr. Winckworth has identified as *Pseudodaphnella lucida*. Three other small and somewhat slender species, *persicus*, *inconstans* and another

closely allied to *inconstans*, have much the same type of slit. As regards sculpture *persicus* seems to be somewhat isolated and *inconstans* to link up on the one hand with *ceylonica* of the genus *Turris* and on the other with *barklyensis* of the genus *Brachytoma*, genera the lip characters of which are linked together by the whole assemblage of small species under consideration, a group which may perhaps be regarded as representing the stock from which the other genera have been derived. To what genus *inconstans* and its allies should be referred I have been unable to determine to my satisfaction. Mr. Winckworth suggests *Clavus* and I am adopting his suggestion, but only with considerable hesitation as the type of this genus appears to be about 2 inches high, whereas *inconstans* and its two Madras allies are quite small and seem to find their natural place among genera composed of more or less minute species.

The Madras genera of Turridae may then be separated as follows, all the large and conspicuous species except *Asthenotoma vertebrata* falling under section 4 of the key.—

- | | | | | | | | |
|---|-----|-----|-----|-----|-----|-----|-----------------------------|
| 1. Slit more or less distinct, usually well developed, strong spiral sculpture present as a rule, ribs rounded, sometimes absent | ... | ... | ... | ... | ... | ... | 2 |
| — Slit more or less indistinct, shell quite small (rarely more than half an inch in height) with narrow and sharply defined ribs, spiral sculpture (? always) microscopically fine or absent | ... | ... | ... | ... | ... | ... | 9 |
| 2. Shell tall and slender, with strong spiral ridges separated by hollows marked by fine ridges parallel to growth-lines; lip thin, anterior canal short, columella with one more or less distinct fold | ... | ... | ... | ... | ... | ... | <i>Asthenotoma</i> , p. 72. |
| — Spire less elevated, without this type of sculpture | ... | | | | | | 3 |
| 3. Shell attaining a height of at least three quarters of an inch, interior of aperture smooth | ... | ... | ... | ... | | | 4 |
| — Shell under half an inch in height, outer lip usually more or less distinctly toothed or finely ridged within, columella callus often somewhat indistinctly wrinkled | ... | ... | | | | | 6 |
| 4 ¹ . Margin of slit in matured outer lip not everted, more or less thin, ribs absent or represented by a spiral line of little more than tubercles | ... | ... | ... | ... | ... | | 5 |
| — Margin of slit in matured outer lip thickened and more or less distinctly everted, ribs elongate but not always very strong | ... | ... | ... | ... | ... | ... | <i>Brachytoma</i> , p. 74. |

¹ Only when the lip is well matured are the distinctive characters of its slit clearly apparent, but fortunately this seems to be the case in most specimens. When the lip is not matured the slit tends to approximate more or less to the thin-margined type.

ERRATUM.

The reference letters to fig. 13 have unfortunately been inserted upside down, and the block has consequently been inverted in printing. In the figure of *A. texta* (c), moreover, the intra-cardinal spiral has come out much too strongly, and the upper cardinal somewhat so.

5. Slit forming a broadly open excavation, position of lower margin of its mouth marked on shell by a spiral shoulder. *Turricula*, p. 73.
 — Slit narrow throughout, whorls not definitely shouldered ... *Turris*, p. 73.
6. Columella callus with a more or less distinct and tooth-like thickening above, margin of slit greatly thickened, transpiral ribs present and overlaid by one or more spiral ridges ... *Lienardia*, p. 76.
 — Callus and margin of slit not greatly thickened, sculpture varied but usually forming a lattice of spiral and transpiral lines ... 7
7. Whorls of spire somewhat numerous, body whorl relatively small with aperture not markedly elongate, lower margin of suture more or less swollen ... ? *Clavus*, p. 76.
 — Spire with somewhat fewer whorls, body whorl relatively higher with more or less elongate aperture, lower margin of suture not swollen ... 8
8. Protoconch not decorated with network of oblique lines ... *Pseudodaphnella*, p. 77.
 — Protoconch decorated with network of oblique lines ... *Daphnella*, p. 77.
9. Spire somewhat tall and slender, body whorl and aperture small ... *Haedropleura*, p. 77.
 — Spire shorter and often broader, body whorl larger with somewhat narrow aperture about as high as spire ... *Cythara*, p. 77.

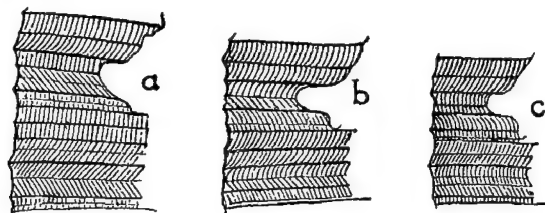


FIG. 13.

Lip and adjoining surface of *Asthenotoma* spp. enlarged to illustrate arrangement of spirals.

Cardinal spirals indicated by crosses beside them.

a. *Asthenotoma vertebrata*.

b. *Asthenotoma coffea*.

c. *Asthenotoma texta*.

The genus *Asthenotoma* is represented by three species so much alike that they can only be distinguished by very close and careful examination, though once their differences have been understood they prove to be definitely distinct. Fresh examples of the two smaller

species differ in colour from those of the largest one, and from one another in their degree of slenderness, but the most reliable characters—especially as they are only ones recognizable in bleached shells—are provided by the spiral ridges. These have a uniform fundamental arrangement, and unless this is carefully borne in mind the three species cannot be separated without great difficulty and often considerable uncertainty. The identity of these spiral ridges is determined by the relation they respectively bear to the different parts of the lip, especially its slit. Two of them, which may be termed the cardinal spirals, end in the upper and lower angles respectively of the mouth of the slit. Between these will usually be found a finer spiral, ending in its terminal angle, which will be referred to as the intra-cardinal. An additional intra-cardinal may be present above it, ending near the middle of the oblique upper margin of the slit. A little above the upper cardinal and close below the suture is a single spiral which may be called the infra-sutural, and below the lower cardinal on the body whorl are a number of infra-cardinals, at least one of which is exposed on the lower whorls of the spire of well-grown specimens of all three species, another often being visible close above or embedded in the suture. The differences between the three Madras species are as follows.—

1. Shell very slender, greyish or brownish, not exceeding half an inch in height, the two cardinal spirals about equally strong, both of them stronger than the infra-sutural, intra-cardinal present *A. coffea* (fig. 13b)¹.
- Shell less slender, lower cardinal spiral more prominent than upper 2
2. Shell greyish or brownish, under half an inch in height, intra-cardinal spiral weak or absent, upper cardinal also very weak, much weaker than infra-sutural *A. texta* (fig. 13c).
- Shell white, sometimes with cloudy transpiral zig-zag brownish bands, upper cardinal spiral well developed, stronger than infra-sutural but less prominent than lower cardinal, intra-cardinal present with or without another above it, three infra-cardinals present on lower whorls of spire above one immersed in suture *A. vertebrata* (figs. 13 a & 14, 2).

¹ When the infra-sutural and infra-cardinal spirals are strong, each of the lower whorls has a narrow double spiral composed of the infra-sutural and upper cardinal, above a broader double spiral composed of the lower cardinal and the infra-cardinal, an arrangement which can sometimes be recognized almost to the apex. Usually, however, the infra-cardinal quickly disappears as the whorls are followed upwards, and sometimes both it and infra-sutural are weak more or less throughout.

The genus *Turricula* is represented by two species which may be separated thus.—

Shell practically smooth, moderately slender, either uniformly white or pale brownish with somewhat extensive white markings	...	...	...	...	...	...	<i>T. tornata</i> .
Shell spirally ridged throughout, though not very strongly, widest part with spiral line of short oblique rib-like tubercles	...	...	...	...	...	...	<i>T. javana</i> .

At least five species of *Turris* occur in the neighbourhood of Madras.—

1. Transpiral grooves entirely absent 2
- At least one spiral ridge crossed by series of transpiral grooves 3
2. Spiral ridge adjoining end of slit with strongly keeled upper margin, which on spire forms broadest part of each whorl, anterior canal particularly long. Colour brown with white markings *T. indica* (fig. 14, 1).
- Spiral ridge adjoining end of slit lightly hollowed with both margins lightly raised, a ridge below it forming broadest part of each whorl, anterior canal much less elongate. Colour white, speckled and blotched with brown *T. variegata*¹.
3. Transpiral grooves confined to ridge from end of slit the (more or less distinctly double) beading of which tends to fade out before slit is reached. A keeled ridge a little below this ridge on whorls of spire (a series of them on body whorl) and a larger keeled ridge immediately below suture, both of them smaller than beaded ridge, anterior canal somewhat elongate. Colour uniformly brown *T. nelliae*.
- Transpiral grooves less restricted 4

¹ Two allied species probably also occur. In *T. acuta* (= *tigrina*), of which the Madras Museum has two specimens said to be from Negapatam, the ridge from the end of the slit resembles that of *T. variegata*, but occupies the widest part of each whorl, and is more strongly hollowed above with the edges very strongly keeled. The anterior canal is almost as long as in *T. indica*. The colour resembles that of *T. variegata*, but the brown markings are confined to the tops of the keels, except for a line of conspicuous spots on a somewhat broad keeled ridge immediately below the suture. In another species, not identified, of which Mr. Crichton has a specimen with lip broken from Mahabali-puram about thirty miles south of Madras, coloured much as in *T. indica*, and the Museum a white specimen from Bombay with lip complete, the ridge from the end of the slit, though hollowed between slightly raised edges, is weak and inconspicuous, and the anterior canal scarcely as long even as in *T. variegata*.

4. Slit followed by a hollow band strongly marked with curved growth-lines, below which on body whorl are several coarsely beaded spirals two of them extending up spire as do also two smaller ones between hollow band and suture ; anterior canal slightly elongate. Colour pale brownish with indistinct longitudinal zig-zag bands ... *T. ceylonica*.
- Slit followed more or less immediately by beaded ridge with growth-lines on either side in form of strong oblique grooves continued into transpiral ridges above and below, anterior canal not elongate. Colour pale yellowish or reddish *T. multiseriata*¹.

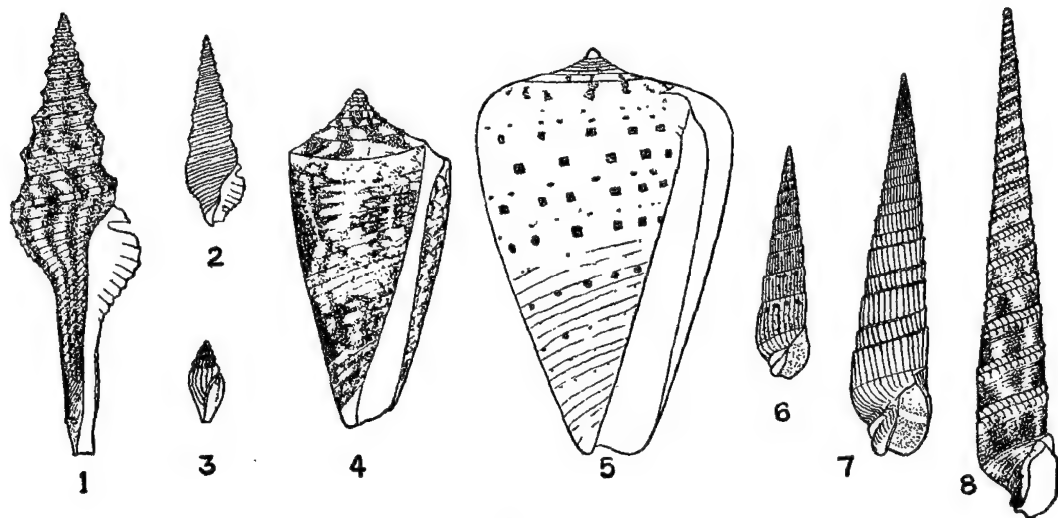


FIG. 14.

- | | |
|------------------------------------|--|
| 1. <i>Turris indica</i> . | 5. <i>Conus betulinus</i> . |
| 2. <i>Asthenotoma vertebrata</i> . | 6. <i>Hastula strigilata</i> var. <i>elegans</i> . |
| 3. <i>Cythara lyrica</i> . | 7. <i>Duplicaria duplicata</i> . |
| 4. <i>Conus amadis</i> . | 8. <i>Terebra commaculata</i> . |

The Madras species of *Brachytoma* may be recognized thus.—

- | | |
|---|---|
| 1. Spirals on lower part of body whorl with transpiral lines of definite (though not always strong) granules, spire not very tall, lower margin of suture more or less swollen, colour yellowish brown | 2 |
| — Spirals on lower part of body whorl not definitely granular, spire usually taller | 4 |

¹ Mr. Crichton has recently collected a taller and more slender specimen, dark brown in colour, which must I think belong to a distinct species though very close to *T. multiseriata*.

2. Granules on base of body whorl widely separated, ribs on spire 10-11 to a whorl, continued upwards across hollow band below swollen margin of suture *B. tayloriana*.
- Granules on base of body whorl close together, ribs extending on to hollow band below suture only in exceptional specimens 3
3. Ribs on spire about 14 to each whorl, elongate, tapering above *B. barkliensis*.
- Ribs on spire about 11 to each whorl, shorter, terminated abruptly above, base of shell somewhat more attenuate than in two preceding species *B. griffithi*.
4. Spiral sculpture faint and even *B. enna*.
- Spiral sculpture strong, shell somewhat more slender 5
5. Shell moderately slender, its sculpture neat and even, whorls more or less shouldered at tops of ribs 6
- Shell very slender, its sculpture rough looking, whorls not shouldered 8
6. Shell pure white throughout, somewhat small, no keeled ridge immediately below suture *B. incerta*.
- Shell brown fading to white on ribs, somewhat larger 7
7. No keeled ridge between suture and hollowed band below it, shell somewhat less slender than that of preceding and following species, of a somewhat paler brown than following species *B. major*.
- A low keeled ridge present between suture and hollowed band below it, brown colour darker, usually extensive but sometimes concentrated in hollowed band below suture *B. crenularis*.
8. Shell pale yellowish brown, very tall, body whorl with faint oblique transpiral lines overlaying spirals, lower margin of suture with somewhat obscure double spiral *B. flavidula*.
- Shell brownish between ribs, especially in upper part of each whorl, extremely slender and somewhat shorter even than *B. incerta*, body whorl with clear oblique transpiral lines overlaying spirals, upper part of double spiral on lower border of suture irregularly beaded, lower line smooth *B. intertincta*.

The genus *Lienardia* is represented by five species as shown in the following key. Mr. Crichton's collection also includes a few others that cannot at present be definitely placed.—

1. Whorls of spire with at least two prominent spirals ... 2
- A single prominent spiral at widest part of each whorl ... 4
2. Spirals rounded, not toothed and not differing very markedly one from another, shell about half an inch high when full grown, moderately stout, more or less uniformly yellowish brown ... *L. obtusicostata.*
- Spirals crested, two (or three on lower whorls) particularly prominent, shell more slender throughout ... 3
3. Shell about half an inch high when full grown, slightly more slender than that of *L. obtusicostata*, a broad band of fine spirals between upper prominent spiral and suture, tinged with deeper brown between ribs especially on spirals ... *L. spurca.*
- Shell only about a quarter of an inch high, much more slender throughout, prominent ridges each forming an acute denticle on crest of each rib, upper one less widely separated from suture than in *L. spurca*, base of body whorl and spiral band immediately below suture purplish or yellowish brown ... *L. gravelyi.*
4. Shell resembling that of *L. gravelyi* in its general proportions but slightly larger, ribs combining with spiral to form line of strongly developed teeth, colour uniformly pale brownish with or without a darker tint on spiral between teeth ... *L. cosmia.*
- Shell much shorter and relatively broader, with larger body whorl more tapered below, and more elongate aperture ... *L. sp.*

The three Madras species that I have provisionally referred to the genus *Clavus* (see above, p. 70) may be separated thus.—

1. Shell smooth and highly polished, with well developed oblique ribs and with spiral depression below suture, but devoid of spiral and transpiral ridges, and of ridges within outer lip ... *C. persicus.*
- Shell strongly sculptured, ribs represented by spiral line of oblique tubercles, outer lip with series of parallel ridges within ...

2. Lower margin of suture somewhat broadly raised, more or less corded as a rule; tubercles between spiral and transpiral grooves on body whorl somewhat low, giving surface an even appearance; colour darkish brown ... *C. inconstans*.
 — Lower margin of suture finely keeled, tubercles between spiral and transpiral grooves on body whorl somewhat coarse, colour paler *C. sp. nr. inconstans*.

Of the genus *Pseudodaphnella* only a single species, *P. lucida*, has yet been identified, and none of the three species of *Daphnella* that have been found.

The genus *Haedropleura* is represented by a single species, *H. pellyi*, an elegant whitish little shell tinged with dark purplish brown below the suture and on the base of the body whorl.

The genus *Cythara* is represented by eight species recognisable as follows.—

1. Shell not glossy, more or less ochraceous or yellowish ... 2
 — Shell more or less strongly glossy (under a lens), more purplish brown or white in colour 5
2. Shell often with faint cloudy darker bands but without fine spiral lines 3
 — Shell not clouded, definite spiral lines present 4
3. Shell somewhat slender, scarcely exceeding a quarter inch in height, ribs somewhat broad and rounded, 8-9 to each whorl, aperture more or less distinctly shorter than spire, colour pale yellowish ochre *C. recta*.
 — Shell somewhat stouter, up to half an inch high, ribs finer, 10-11 to each whorl, height of aperture about equalling that of spire, colour pale reddish ochre *C. lyrica* (fig. 14, 3).
4. Shell about half an inch high, somewhat broad at base, tops of ribs elevated above suture *C. capillacea*.
 — Shell somewhat larger, tapered at base, tops of ribs not elevated *C. vittata*.
5. Ribs distinctly though not strongly angled, shell not exceeding a quarter inch in height 6
 — Ribs evenly curved, 10-12 to a whorl, shell about half an inch high 7

6. Shell minute, ribs denticulately shouldered near top, about
 10 to a whorl *C. nana*.
 — Shell larger, ribs angled near their middles on spire, without
 denticle, 7-8 to a whorl *C. sp. nr. stromboides*.
 7. Shell ribbed throughout, purplish in colour, aperture
 shorter than spire *C. townsendi*.
 — Lower part of body whorl without ribs, aperture about as
 long as spire, shell thin, white, sometimes with brown
 stains *C. cylindrica*.

Cone Shells (Conidae).

Shell with large and more or less cone-shaped body whorl, spire being broad and low ; aperture long and narrow, top of outer lip more or less extensively detached from base of spire.

The slit-lips are included by Theile in this family which he therefore treats as a sub-family along with them. Cone shells are, however, so very distinct in appearance that it seems better to retain them as a separate family as was done by earlier authors, even though this contains only a single genus *Conus*.

Cone Shells are represented at Madras by the following species.—

1. Spire more or less elevated ; or upper part of body whorl
 more or less rounded 2
 — Surface of spire (apex excepted) horizontal, upper part of
 body whorl acutely angular, lip separated from body
 whorl by deep cleft 7
2. Lip separated from body whorl by deep cleft, spire mode-
 rately high, surface of well grown shells normally¹
 decorated with numerous well defined white patches ... 3
 — Cleft between lip and body whorl very shallow, spire less
 high, surface without well defined white decoration ... 4
3. Sides of spire more or less straight, apex not specially
 acute, decoration in fresh specimens particularly delicate
 with white patches finely outlined by dark brown and
 so arranged as to look like overlapping but somewhat
 irregular scales *C. textile*.
 — Sides of spire concave, apex acute, markings less delicate,
 white patches without dark outlines *C. amadis* (fig. 14, 4).

¹ Mr. Crichton has a pure white specimen of *C. amadis*, presumably an albino as it was alive when found.

4. Upper part of body whorl slightly angled but not tuberculate ; shell slender, height about $2\frac{1}{2}$ times greatest breadth *C. radiatus*.
- Upper part of body whorl either rounded or tuberculate ; shell stout, height about twice greatest breadth in well grown specimens, somewhat greater in smaller ones ... 5
5. Upper part of body whorl not tuberculate, shell large ... 6
- Upper part of body whorl with line of low tubercles ... *C. ceylanensis*.
6. Purplish brown, usually with more or less distinct dark spiral lines on body whorl and more or less uniformly dark coloured and slightly elevated spire, sometimes bordered by a pale band extending round top of body whorl from upper angle of aperture *C. figulinus*.
- Yellowish brown with spiral lines of blackish spots on body whorl, spire still less elevated, pale with blackish linear marks across whorls *C. betulinus* (fig. 14, 5).
7. Apex of spire moderately large, shell somewhat slender, ornamented with spiral lines or bands of dark spots ... *C. monile*.
- Apex of spire smaller, shell somewhat stouter, ornamented with dark and light patches or bands *C. voluminalis*.

Auger Shells (Terebridae).

Spire elongate with numerous whorls, body whorl not enlarged, lip thin, operculum oval. Eyes at tops of tentacles or neither eyes nor tentacles present. Foot small.

This family contains only three genera, *Hastula*, *Duplicaria* (= *Diplomeriza*) and *Terebra*, all of which are found at Madras, but they are not sharply distinguishable for species transitional in character occur which link them completely together. In *Hastula* the surface is glossy and spiral sculpture is usually absent, being represented at most by a few widely separated impressed lines which are interrupted by the ribs. *Duplicaria* resembles *Hastula* except that the whorls are divided into two sections by a strong spiral groove. In *Terebra* the surface is usually less glossy and there are more spiral striations though they are sometimes rather faint. The tops of the ribs are often nipped off in this genus to form a band of tubercles, but not quite the type of band in this position typical of *Duplicaria*.

Hastula is represented by four species. *H. traillii* is a white shell, usually with a faint bluish band a little below the suture. Its ribs, though numerous, are so faint that the shell appears entirely smooth at first sight. The other three species are brownish. In *H. strigilata*

var. elegans (fig. 14, 6), which has a white band spotted with brown immediately below the suture, the ribs are numerous, flattened and close set, and are finer than in the typical form of the species, which is a larger shell not known from Madras. In the other two species the ribs are more elevated, angular, fewer and more widely separated. *H. tenera* is a very small shell but somewhat less slender than any of the others and with fewer ribs even than the somewhat longer *H. longiscata*. Near the top of each whorl it has either a dark spiral line or dark patches between the ribs. *H. longiscata* is more or less transitional between this genus and the other two, fragments of spirals being present between the ribs. The uppermost of these fragmentary spirals—the band above which is whitish—is coarse, the others are very fine, and as a rule none of them cross the ribs. Traces of the coarse uppermost one can sometimes be recognized also in *H. strigilata*, as punctures between the tops of the ribs.

Duplicaria is represented by three species. In *D. concolor* the part of each whorl above the spiral groove is barely half as broad as the part below and the ribs are widely spaced and distinctly crested. Fresh specimens may be either greyish with a whitish band immediately above the suture or pale yellowish throughout. *D. raphanula* is larger and has the band above the spiral groove equally narrow and the ribs close together and almost flat. Fresh specimens are decorated with more or less rectangular brownish blotches, usually with a white spiral band a little below the groove. *D. duplicata* (fig. 14, 7) is the largest Madras representative of the genus. In it the part above the spiral groove is fully half as broad as the part below and the ribs are close together and still more flattened. Several different colour varieties occur.

The genus *Terebra* is represented by eight species. *T. tantilla* is a minute shell linking *Terebra* with *Duplicaria*, a genus in which it might with almost equal propriety be placed. But the part of the whorl above the spiral constriction does not have quite the character typical of the latter genus and a number of fine and somewhat close spirally impressed lines are clearly visible below it under a lens. The spiral constriction, and sometimes the band above it, are more or less dark reddish brown, as is also the base of the body whorl or at least a band above the columella base. The rest of the shell is white or pale yellow, sometimes with an indistinct additional dark band a little below the middle of the basal whorls. *T. persica* is a smallish shell with ribs somewhat as in the preceding genera, but with close spiral striation between them and not very glossy. The middle of each rib is lower than the ends, the upper end especially being sometimes almost tubercular. The colour is dull brownish, sometimes with a whitish band immediately below the suture. *T. tricineta* and *T. textilis* are somewhat smaller and rarer than *T. persica*, and like it brownish in colour. Both have a somewhat broad and more or less tuberculate band just below the suture. In *T. tricineta* this is followed by a slender raised line which is separated by a broad flattened area, crossed by more or less distinct raised transpiral lines, from a band of intermediate

width situated immediately above the next suture. In *T. textilis* the band below the suture, which is sometimes whitish, is succeeded by a series of raised but flattened narrower bands, all more or less alike and crossed by low ribs which form continuations of the tubercles on the uppermost band.

The other four species of *Terebra* are much larger. *T. triseriata* is brownish in colour and has two bands of tubercles (of which the upper is the larger) immediately below the suture and a much smaller one immediately above the next suture, with three or four scarcely tuberculate spiral bands between. It is very rare and only three specimens have yet been found at Madras. *T. anilis* is brownish in colour with two obliquely ribbed bands (of which the upper is again the larger) immediately below the suture and about four smooth raised spiral lines below them. *T. eximia* is whitish with brown spots on the band immediately below the suture, which is practically smooth. There are about four raised spirals between this band and the next suture. *T. commaculata* (fig. 14, 8) is whitish with brown blotches and has two bands, sometimes tuberculate, immediately below the suture followed by a series of raised spirals the interstices between which are transversely ridged.

GASTROPODA EUTHYNEURA OPISTHOBRANCHIA.

The Gastropoda Euthyneura are divided into two orders, the *Opisthobranchia* which breathe by means of gills and are practically all marine, and the *Pulmonata* which breathe by means of a lung (the modified mantle cavity) and are practically all either land or freshwater forms.

The Opisthobranchia include two broad groups, the Sea Slugs and the Sea Butterflies or Pteropods. Sea Slugs fall into two sub-orders, *Tectibranchia* in which a shell and mantle are usually present, and *Nudibranchia* which mostly have no shell in the adult state. The Pteropods seem to be specially related to the former, and are included among them by some authors.

TECTIBRANCHIA (= PLEUROCOELA).

Two tectibranch sea slugs, *Haminoea crocata* and *Bursatella leachii*, are sometimes found crawling about in large numbers in the backwaters. *Haminoea crocata* (fig. 15, 5) is barely an inch long when expanded, with a squarish flattened head deeply cleft behind, and a thin yellowish, greenish or pinkish shell with inrolled spire. *Bursatella leachii* is much larger, being up to about three inches long, and has two pairs of branched tentacles on the head, and other small processes, many of them branched, scattered over the body which is greenish grey or brownish in life, usually decorated with beautiful eye-like spots. Parapodia or upward extensions of the sides of the foot are present, but the shell is rudimentary. Still larger, but less common, is a backwater sea hare, *Aplysia fimbriata*, which may attain a length of fully six inches when expanded. Its large ear-like shell (fig. 15, 6) is almost entirely

hidden by the parapodia, being less developed than that of *Haminoea* with only the barest rudiments of a spine. The tentacles are not branched, though the large front pair are broad and folded, and the body is without other processes. In life this species is of a somewhat

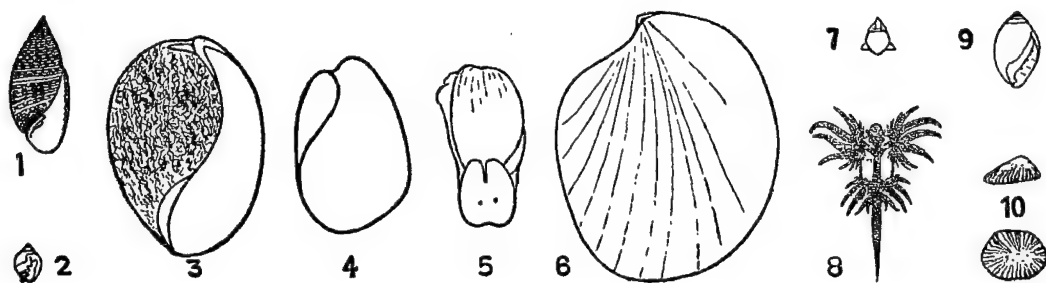


FIG. 15.

1. *Pupa solidula*.
2. *Ringicula propinquans*.
3. *Bulla ampulla*.
4. *Philine orientalis*.
5. *Haminoea crocata* (animal with shell).

6. *Aplysia fimbriata*.
7. *Cavolinia longirostris*.
8. *Glaucus marinus* (from ventral side).
9. *Melampus singaporensis*.
10. *Siphonaria basseinensis*.

olivaceous brown colour with darker blotches more or less linked together by an irregular network of dark lines. In 1941 this *Aplysia* was fairly abundant in the Ennur backwater at the end of January, but most of the specimens found the following week were dead or dying though live specimens continued to be obtainable till at any rate the end of March. In 1939 Mr. Crichton found a single specimen, probably of a different species, in the Adyar backwater, together with specimens of *Bursatella*, towards the end of February. In 1940 and 1941 no specimens of *Bursatella* have been found at all either at Adyar or Ennur. The only dated record we have for *Haminoea crocata* is July 8, 1939. Concerning living specimens of *Hydatina velum*, see Crichton, *Journ. Bombay Nat. Hist. Soc.* XLII, 1941, p. 332.

Philine orientalis, which attains a length of about an inch, is sometimes brought up by fishermen in large numbers. The head and foot are large and the foot has well developed backwardly directed side processes which are visible from above on either side of the head. The relatively small shell is entirely concealed within a posterior lobe which, with the head and the side lobes of the foot, gives the upper side a characteristic four-lobed appearance.

Both *Aplysia* and *Bursatella* belong to the family Aplysiidae, but *Haminoea* belongs to the family Atyidae, *Philine* to the family Philinidae, and *Hydatina* to the family Hydatinidae. In addition to these families of which living specimens are more or less common, there are a number of others of which shells only have yet been collected, and all species of the shells known to be found at Madras are dealt with below. Only in the Ringiculidae is a definite anterior canal present.

Acteonidae.

Shell spiral, mostly with elevated conical spire of few whorls, which as a rule have impressed spiral lines, aperture narrowed above, columella lip usually with one or two folds, foot with horny operculum. Animal capable of retracting within shell, sole narrow, head shield large, produced behind into two triangular lappets without externally visible sense organs.

The Madras species may be distinguished from one another as follows:—

1. Columella lip without strong fold; shell moderately large, bright crimson with white interrupted spiral bands, spire depressed *Bullina bruguieri*.
- Columella lip with at least one strong fold, spire more elevated 2
2. Basal columellar fold single, additional fold scarcely if at all developed (*Acteon*) 3
- Basal columella fold double, additional fold more or less distinct (*Pupa* = *Solidula*) 4
3. Shell moderately large, spire somewhat low *Acteon flammeus*¹.
- Shell smaller and more slender, with somewhat taller spire. *Acteon* spp.².
4. Shell moderately large, pale straw coloured with numerous spirally arranged small dark spots, upper fold on columella lip not very prominent *Pupa solidula* (fig. 15, 1).
- Shell much smaller, white, upper fold on columella lip prominent *Pupa affinis*.

Ringiculidae.

Shell small, more or less round with small conical spire, colourless; outer lip thick, often with a tooth-like process, columella lip with two strong folds near base and often a tooth above, anterior canal deeply hollowed; operculum absent. Animal capable of complete retraction into shell, foot widened in front, head shield broad and short with a median lappet behind.

Two species are not uncommon, *Ringicula encarpiferens* with impressed spiral lines and low spire, and *R. propinquans* (fig. 15, 2), with smooth shell and somewhat more elevated spire.

¹ The only specimen yet found at Madras is pale pink with three spirals of ill defined white spots on the body whorl instead of white with reddish crescents or flames as in the form from which the species takes its name.

² There are two such species, one spirally lined throughout, the other a thinner shell of slightly different shape in which the spirals are fainter and practically confined to the body whorl, especially its lower part.

Hydatinidae.

Shell broadly oval, thin with closely adherent periostracum, spiral colour bands present, spire more or less inrolled, aperture wide. Animal able to withdraw into shell, foot large with anterior angles extended and large side lappets that can be extended over shell. Head shield large with two well developed lappets behind and one or two pairs of spoon-like tentacles with a rhinophore between them.

Hydatina velum, a somewhat large and fragile pale brownish shell with three spiral white bands outlined with black, one at the top, one in the middle and one at the bottom, is the only species known from Madras, where it is not uncommon.

Bullidae.

Shell broadly oval, comparatively thick, usually speckled or clouded with colour, spire deeply sunk in an umbilicus-like cavity, aperture broad in front, somewhat narrow behind, lips not thickened. Animal retractile into shell; foot somewhat short, broad in front, rounded behind; head shield with two well developed lappets behind.

This family is represented by only one species, *Bulla ampulla* (fig. 15, 3), of a mottled purplish brown colour.

Atyidae.

Shell entirely external as a rule, but its size in proportion to that of animal varied, animal in some species not being capable of complete retraction within it. Foot with well developed side lappets, head shield either notched or straight behind.

The only representative of this family is *Haminoea crocata*¹ (fig. 15, 5), the animal of which has been referred to above, p. 81. The shell is not unlike that of *Bulla ampulla* in shape but has no cavity above the inrolled spire, and is thin and fragile and much smaller. It is usually yellowish in colour, occasionally pinkish.

Retusidae.

Shell cylindrical, spindle- or pear-shaped with sunk or elevated apex, animal retractile within it, foot without lateral extensions, head shield notched behind.

This family contains two genera, of which *Retusa* is represented at Madras by the minute pear-shaped *R. pyramidata* (fig. 16 a) and *Volvula* by a slender spindle-shaped unidentified species (fig. 16 b) of which there is a single specimen in Mr. Crichton's collection, the only one yet found.

¹ Mr. Winchworth tells me that *H. tenera* will probably also be found. I have not collected these shells as carefully as I should do if I were to be longer in Madras.

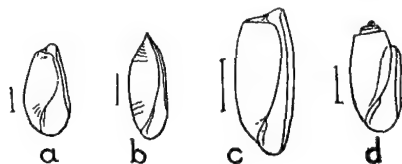


FIG. 16.

a. *Retusa pyramidata*.c. *Cylichna protracta*.b. *Volvula* sp.d. *Acteocina townsendi*.

The natural size of each is indicated by the lines beside the figures, all the figures being enlarged.

Scaphandridae.

Shell usually white, its apex usually sunk, when elevated heterostrophic.

Two genera are represented, *Acteocina* with exposed and heterostrophic spire, and *Cylichna* with inrolled spire. *Acteocina townsendi* (fig. 16 d) is a small white shell with the spire approximately rectangular in profile and the outer lip distinctly curved. Two rarer forms also occur, *A. involuta* in which the spire is taller and more acute-angled in profile, and *A. lactuca* in which it is almost flat.

The genus *Cylichna* is represented by three species, *C. protracta* (fig. 16 c), a species that seems indistinguishable from the British *C. cylindracea*, and a smaller and much more slender species not yet identified. The first two are about four times as long as broad, the first relatively a little shorter than the second. The third is five or six times as long as broad. In the first the upper angle of the outer lip is less raised above the inrolled spire and the base of the aperture less elongate than in the second, these features of the second being somewhat intensified in the third. Only a few shells of each species have been found, all being white except one each of the first and second, in both cases the smallest one. These have a periostracum that is pale horn-coloured in the middle but deep reddish brown at both ends, that of the first but not the second showing in an intensified manner the otherwise almost imperceptible spiral striations of the shell.

Philinidae.

Shell much smaller than animal, enclosed in mantle, more or less thin, colourless, oval with inrolled spire and broad aperture.

Only one species, *Philine orientalis* (fig. 15, 4) is known from Madras, concerning which see above, p. 82.

Sea Hares (Aplysiidae).

Shell small in proportion to animal, horny or calcareous, broadly expanded with more or less rudimentary spiral, more or less completely covered by mantle, sometimes disappearing completely in adult. Head with four tentacles but without defined shield. Foot with parapodia upwardly directed to form and protect a cavity over shell, and with long narrow sole.

Concerning the animal of the two commonest Madras species, *Aplysia fimbriata* and *Bursatella leachii*, see above, p. 81. The adult has no shell in the latter. *Aplysia fimbriata* has a broad, rounded, slightly hollow and more or less horny shell (fig. 15, 6) up to about an inch and a half in diameter, with the barest rudiments of a spiral—not even inrolled—behind. Other species of *Aplysia* probably occur but have not been satisfactorily identified.

SEA BUTTERFLIES (PTEROPODA).

A few shells of the sea butterfly *Cavolinia longirostris* of the family *Cavoliniidae* have been collected by Mr. Crichton. They are minute whitish objects of the form shown in fig. 15, 7.

NUDIBRANCHIA (=ACOELA).

Several creeping forms occur,¹ including *Kalinga ornata*, *Armina formosa*, *Armina variolosa* and an undetermined species of *Discodoris*, but the only nudibranch that seems to be at all frequently thrown up on the beach is the curious little blue pelagic *Glaucus marinus* (fig. 15, 8). When in good condition in the sea it floats on its back which is whitish, the ventral surface—which is thus in practice the upper surface—being of a beautiful deep blue, showing that relative depth of colour is correlated with light and shade rather than with morphology.

Kalinga ornata is a large sea slug with its sparsely tuberculate upper surface adorned with a circle of well-developed feathery gills behind, and more or less fringed with much smaller processes of a similar kind. The *Discodoris*, which was found among mussels, etc., in the harbour, is much smaller, with retractile gills in a much closer circle. Its head is cleft in the middle in front and its upper surface is somewhat rough. Both species of *Armina* are moderately large, *A. formosa* having the upper surface decorated with numerous longitudinal crests, which are replaced in *A. variolosa* (a species I have not myself seen) by tubercles. These tubercles often tend however, to fuse together to form a varying number of longitudinal ridges, especially in front, with one or two large varioles interspersed.

GASTROPODA EUTHYNEURA PULMONATA.

Of the few pulmonate or lung-breathing molluscs that have reverted to a more or less marine life two families are represented, the Ellobiidae belonging to the Actophila—a group with spiral shell—and the Siphonariidae belonging to the Patelliformia or limpet-like group.

Ellobiidae.

Two genera occur, *Melampus* in which the shell is circular in transverse section and the columella lip is scarcely if at all reflexed at base, and *Pythia* in which the shell is slightly

¹ Mr. Winckworth informs me that he has seen specimens of a large spotted nudibranch, *Euselenops luniceps* from Ennur, and Mr. Crichton has subsequently obtained from fishermen specimens tentatively identified as *Pleurobranchaea brocki*, *Scyllaea marmorata* and *Scyllaea viridis*.

flattened—being oval in transverse section—and the columella lip is very strongly reflexed at base. Both have strong folds on the columella and, except for the minute *Melampus avenaceus*, the Madras species have teeth or ridges inside the outer lip. *Melampus sincaporensis* (fig. 15, 9) is a stoutly spindle-shaped shell with very strong folds on the columella and four teeth inside the outer lip, of which the two lowest are very large, the next rather small and the uppermost moderately large. In *M. fasciatus*, of which the only specimen yet known from Madras is a small one from the harbour arm in the Museum collection, the body whorl is lightly shouldered, pushing the broadest part of the shell to a little above the middle, the folds on the columella are somewhat smaller, and the teeth inside the outer lip are more numerous and of more uniform and moderate size. Both species may be either uniformly brownish or have conspicuous dark and light spiral bands. *M. avenaceus* is a minute and more slender colourless shell with only one strong fold on the columella and no tooth or ridges inside the outer lip. *Pythia plicata*, which seems always to be uniformly brownish when not encrusted or corroded, has larger columella folds than even *Melampus sincaporensis* and numerous stout and somewhat irregular teeth within the outer lip.

Lung Limpets (Siphonariidae).

These limpet-like shells can be distinguished from the true limpets with which they are often found by the presence of a shallow radial groove on the right side of the inner surface, which makes them more or less distinctly asymmetrical. And in the single species known from Madras—a very small one, *Siphonaria basseinensis* (fig. 15, 10)—the apex is slightly behind the middle of the shell instead of in front of it as in true limpets.

GASTROPOD EGG CAPSULES.

The eggs of snails are mostly minute, developing into bilaterally symmetrical larvae of microscopic size. These swim about by the rythmical lashing of hair-like processes of a lobed organ (*velum*) in front of the mouth, which is the most characteristic distinctive feature of free-swimming molluscan larvae. In Gastropod larvae the original symmetry soon gives place to the asymmetry characteristic of the order, and as the shell grows the swimming organ disappears and the adult mode of life is adopted.

Some or all of this development takes place within sandy, gelatinous or horny capsules, often of considerable size since each capsule may contain a large number of eggs. Such capsules are commonly found on the beach at Madras and elsewhere along the coast, and Hornell has figured several in his "Common Molluscs of South India" (Madras Fisheries Department, 1922).

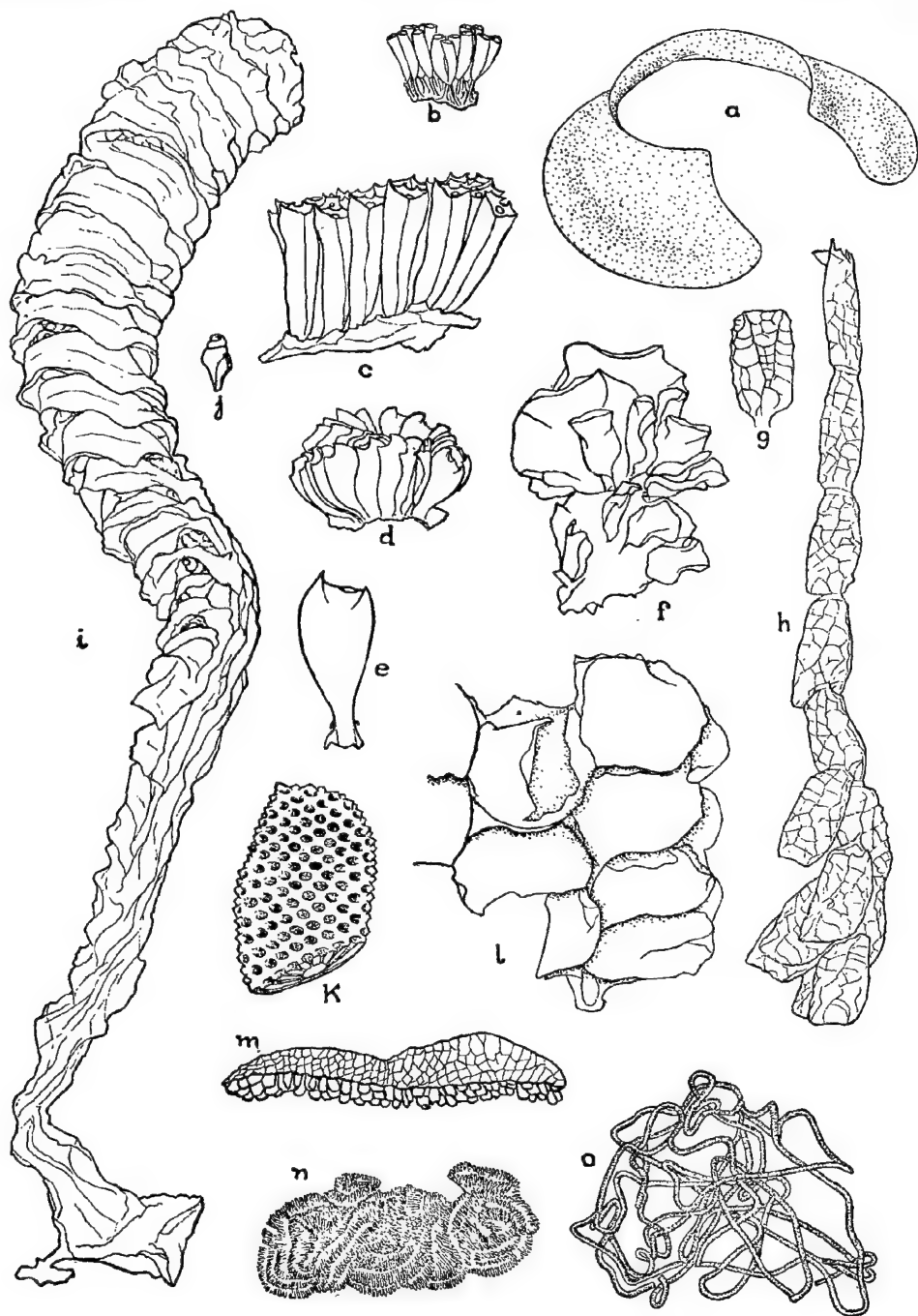


FIG. 17.
EGG CAPSULES OF MARINE SLUGS AND SNAILS.

The egg capsules of snails belonging to the genus *Natica* form thin sheets of characteristic form (fig. 17 a), strengthened by the inclusion of much sand within their texture. Those which are found in the backwaters are evidently produced by *N. marochiensis*, the common backwater species and the only one that seems to live there in the neighbourhood of Madras all others apparently being exclusively marine.

Gelatinous spawn in long tangled strings is produced by the sea hares. Part of a mass evidently laid by a specimen of *Aplysia fimbriata*, found close beside it in the Ennur backwater late in the spring of 1940, is shown in fig. 17, o. Hornell (*loc. cit.*, p. 146, fig. 33) gives a figure of the spawn of *Notarchus*, doubtless the common species now known as *Bursatella leachii*, from which it is evident that this is not very different from that of *Aplysia*. Another type of whitish gelatinous spawn (fig. 17 n) is produced by *Hydatina velum*.

The horny cases that have been found at Madras are laid in groups in one or other of three different ways, each characteristic of one or more types of case, some being attached side by side singly to some solid object from which they stand up more or less vertically, some being strung together in bunches, and some forming more or less closely packed masses, each kind of mass commonly with a characteristic shape of its own.

The egg cases of the floating violet snail *Fanthis* are arranged in the first of the above three ways, being attached side by side to the lower surface of the flat secreted to keep the snail from sinking to the bottom. Those of *F. globosa* are illustrated in fig. 17 m. The arrangement of those of the commoner *F. roseola* is slightly different, being as illustrated by Hornell (*loc. cit.*, p. 120, fig. 13).

Other egg cases arranged side by side are of three main types; one more or less cylindrical without ridges, another somewhat similar but with strong longitudinal ridges, and a third that is broad and flat like a purse.

The small stalked capsules of the first of these types, shown in fig. 17 b, are from a group found close beside a large *Thais bufo* on concrete blocks east of the harbour entrance, and as the eggs they contained were noticed a few days later to have developed into quite young active larvae they must have been perfectly fresh when found and had doubtless been laid by the *Thais* beside them. Similar capsules that get washed up on the beach are as a rule

EXPLANATION OF FIG. 17.

- | | |
|--|---|
| a. <i>Natica marochiensis</i> . | h. Bunch of another kind of reticulate capsule. |
| b. <i>Thais bufo</i> . | i. Column of egg capsules of sacred chank. |
| c. ? <i>Murex</i> sp. | j. Embryo shell from chank capsule. |
| d. ? <i>Conus</i> sp. | k. Unidentified egg mass. |
| e. ? <i>Conus</i> sp. (larger type of capsule, one of a group). | l. Do. |
| f. Bunch of two sizes of simple capsules somewhat like those shown in figs. d and e. | m. <i>Fanthis globosa</i> . |
| g. Single reticulately ridged capsule from large bunch. | n. <i>Hydatina velum</i> . |
| | o. <i>Aplysia fimbriata</i> . |

much taller with shorter or no stalks, though the latter difference may perhaps be due partly to shrinkage in drying. Some, like the *Thais bufo* capsules figured, are straw-coloured, some purple. They closely resemble those figured by Hornell as probably those of a *Murex* (*loc. cit.*, p. 132, fig. 18), but the capsules of *Murex erinaceus* are described in the *Cambridge Natural History* (Molluscs, p. 124) as triangular with a short stalk. So possibly Hornell's capsules may have been those not of a *Murex* but of one of the various species of the allied genus *Thais*.

Only a single group of ridged capsules arranged like those of *Thais* has been found (fig. 17 c). These are larger than the ones without ridges already described, resembling those figured by Hornell as probably those of a *Fasciolaria*, but as some of them are stained with purple it seems more likely that they belong to a Muricid, probably *Murex* or *Rapana* in view of their size. I have no other clue to their identity. They are slightly flattened with a pair of strong longitudinal ridges, one on each side, between which are two more ridges behind and one in front, each ridge ending in a small process of the upper margin.

Groups of purse-like capsules (fig. 17 d and e) are more often washed up. The capsules vary considerably in size, but those of each group are uniform in this respect. In other respects, except for a single group, those of all groups are much alike. Hornell (*loc. cit.*, p. 141, fig. 28) and the *Cambridge Natural History* (Molluscs, p. 125, fig. 39 B) both refer them to the genus *Conus*. The single group of purse-like capsules of somewhat different form from the others has its capsules closely pressed together to form a single line. Their walls are so delicate that their exact form is difficult to determine satisfactorily in their dried condition, but the margins evidently bear several distinct teeth.

Capsules that are strung together in bunches are of a single general type, being flattened with both surfaces more or less strongly ridged, but are of three different kinds. The simplest kind is represented by two empty capsules, one attached to the face of the other, and by three clusters (? parts of a single larger cluster) of large similar capsules to the faces of which many others of the same type but only about a quarter their size are attached—presumably the capsules of a smaller but closely allied species. Part of one of these mixed clusters is shown in fig. 17 f. Capsules of this simple type, though strongly compressed, are slightly concave on one side and convex on the other, the upper margin—which is occupied throughout its whole length by a large aperture—being lightly bowed as seen from above. But the outline as seen from in front is rounded and almost as broad as high, with the upper margin straight. Both faces bear ridges, oblique at the sides, more vertically arranged towards the middle line, and strongest at the margin; but whereas on the convex surface these ridges continue along the top, on the concave surface they are absent between two somewhat inwardly curved ridges that extend downwards from the upper angles, recalling the ridges similarly placed in the *Conus* capsules already noticed (fig. 17 e). The second kind is that

composing a bunch collected by Mr. Crichton early in October, 1940, the largest bunch that has been found. It consists of somewhat more elongate capsules (fig. 17 g), all of them closed, each being covered by a network of very strong ridges among which on one face but not on the other a pair extending obliquely downwards from the upper angles stand out in a way that seems to indicate their homology with the pair found in this position in the simpler kind just described. This large bunch has two main branches in each of which the capsules are clustered as in the lower part of the bunch shown in fig. 17 h, but much more densely. The bunch shown in fig. 17 h, consists of the third kind. They are smaller and narrower, and are covered with a network of ridges, but though on one face of some of them there is in this network a suggestion of the fundamental pattern noted in the first two kinds and in *Conus* capsules, it is by no means clear. If this resemblance should be taken to indicate actual relationship to *Conus* of the three types of capsule that have been found clustered in bunches, they should belong to one of the other families of *Toxoglossa*, i.e., to the slit-lips (*Turridae*) or auger shells (*Terebridae*), for which they seem somewhat large, or possibly to other species of *Conus*.

The best known massed capsules from Indian seas are those of the chank and melon shells, both of which have been figured by Hornell (*loc. cit.*, p. 126, fig. 16 and p. 137, fig. 22 respectively). Both are sometimes found at Madras. In the egg-mass of the chank (fig. 17 i), which affords a transition between grouped and massed capsules, the somewhat flattened capsules are arranged in a single line with their broad faces in contact and their bases united, the whole mass forming a column with a slight spiral twist. Of the numerous eggs each capsule contains when first deposited only a few complete their development up to the comparatively large size at which they are liberated (fig. 17 j). Sea water is able to circulate in the capsules during embryonic development through the slit-like aperture in the lower wall of each.

Capsules of the melon shell (Hornell, *loc. cit.*, p. 137, fig. 22) are closely packed into much larger and more solid masses. Mr. Crichton informs me that he has seen these egg-masses at Madras, and also masses intermediate in character between them and the one shown in Hornell's fig. 23 (*loc. cit.*, p. 137).

The masses illustrated in fig. 17, k and l, remain unidentified. In the former the capsules are somewhat small and are arranged radially with spaces between them and up the centre of the mass, the mass being held together by bonds uniting the outer corners of the capsules one to one another. The capsules open into the protected space on the middle. Except for their large size and dark colour the capsules shown in fig. 17 l are not unlike those of the common European whelk, but the only available fragment of the mass to which they belonged suggests that it originally formed part of an incrustation rather than of a more globular cluster such as that of the European whelk.

LIST OF IDENTIFIED GENERA AND SPECIES AND OF REFERENCES TO LITERATURE.

References to authorities could not be fitted into the above account of the shells of the Madras beach without awkwardness. They are therefore given below. A complete bibliography would be out of place and is in any case impossible, but an attempt has been made to indicate for each species, wherever possible, either a helpful figure or a recent reference from which earlier references, often with figures, can readily be traced.

This list has been drawn up by Mr. H. Chennappaiya, Curator for Zoology (since retired), aided by notes kindly supplied by Mr. Winckworth. For it proved impossible for me to do it myself before leaving Madras, since when I have not had the requisite library facilities. I take this opportunity of thanking him for this and other help.

It should be pointed out here that, as the paper deals primarily with the remains washed up on the beach, the inclusion of a species in this list does not necessarily imply that it lives anywhere in the immediate neighbourhood. In some cases indeed—e.g., *Turbo marmoratus*—this seems most improbable. Species marked with an asterisk are referred to but are either not recorded from Madras or are recorded only with some uncertainty.

Reeve's "Conchologia Iconica" (published 1843-1878), of which the first fifteen volumes were prepared by himself and the remaining five after his death by Sowerby, is so frequently mentioned below that to avoid unnecessary repetition of the title it is referred to briefly as "Reeve." Each of its volumes contains a series of monographs on individual genera, the plates and figures of which are numbered independently. The volume number is therefore quoted in capital Roman figures, followed after a comma by the plate number in small Roman figures and by the figure number in ordinary numerals.

References to Schepman without further details all relate to his monograph of the Prosobranchia of the Siboga Expedition (*Siboga-Expeditie*, Livr. XLIII ii, Monogr. XLIX, Leyden, 1909).

Haliotidae.

Haliotis varia Linnaeus. Schepman, p. 76.

Fissurellidae.

Diodora lima (Sowerby). *Fissurella lima* Sowerby, *Thesaurus* III (London, 1862), p. 198.

Diodora townsendi (Melvill). *Fissurella townsendi* Melvill, *Mem. Proc. Manchester Lit. Phil. Soc.* XLI (7), 1897, p. 20, pl. vii, figs. 27.

Emarginula peasi Thiele, *Syst. Conch. Cab.*, Sciss und Fissurelliden (Nürnberg, 1915), p. 87, pl. xviii, figs. 7-8.

Emarginula incisura A. Adams. Reeve XIX, iii, 18.

Scutus unguis (Linnaeus). Schepman, pp. 94 and 99-101.

Patellidae.

Patella cernica (H. Adams, = *novemradiata* Quoy and Gaimard 1834, non Fischer 1807). *Nacella (Cellana) cernica* H. Adams, *Proc. Zool. Soc. London*, 1869, p. 273, pl. xix, figs. 7.

* *Patella radiata* Born 1878 (= *reynaudi* Deshayes). *Patella aster* + *petalata* + *luzonica* Reeve VIII, xxii 56, xxx 80, and xxxi 86.

* *Patella lentiginosa* Reeve VIII, xlvi, 110.

Trochidae.

Calliostoma tranquebarica (Chemnitz). *Zizyphus tranquebaricus* Reeve XIV, iii, 15.

Trochus stellatus Gmelin (= *incrassatus* Lamarck). *Trochus incrassatus* (non *stellatus* Philippi). Reeve XIII, xiii, 77.

Gibbula stoliczkanica G. and H. Nevill. *J. Asiatic Soc. Bengal* XXXVIII (ii), 1869, pp. 158-159.

Clanculus microdon (A. Adams), *Proc. Zool. Soc. London* XIX, 1851, p. 162.

Euchelus asper (Gmelin). *Euchelus indicus* A. Adams, *Proc. Zool. Soc. London*, XXIII, 1855, p. 316;

Euchelus asper Tryon, *Man. Conch.* XI (Philadelphia, 1889), pp. 431-2, pl. xxxviii, figs. 13-14.

Trochidae—cont.

- Euchelus asper* var. *tricarinata* (Lamarck). *Trochus tricarinatus* Fischer, Kiener's *Coq. Viv.* XI (Paris, 1878), p. 287.
- Euchelus circulator* (Anton). *Trochus circulator* Anton, *Zeitschr. f. Malak.*, 1848 (1849), p. 103; Tryon, *Man. Conch.* XI (Philadelphia, 1889), p. 432, pl. xxxvii, fig. 16.
- Euchelus circulator* var. *proxima* (A. Adams). *Euchelus proximus* A. Adams, *Proc. Zool. Soc. London*, XXII, 1854 (1855), p. 316.
- Conotrochus holdsworthana* (G. & H. Nevill). *Gibbula holdsworthana* G. & H. Nevill, *J. Asiatic Soc. Bengal* XL (ii), 1871, p. 3.
- Umbonium vestiarius* (Linnaeus). *Rotella vestiaria*. Reeve XX, iii, 12.
- Minolia variabilis* (A. Adams). *Margarita variabilis* A. Adams, *Proc. Zool. Soc. London* XIX, 1851, p. 191.
- Minolia biangulosa* (A. Adams). *Margarita biangulosa* A. Adams, *Proc. Zool. Soc. London* XXII, 1854 (1855), p. 40. *Minolia biangulosa* Tryon, *Man. Conch.* XI, p. 265, pl. xxxvii, fig. 7.
- Minolia impressa* (G. & H. Nevill), *Solarium impressum* G. and H. Nevill, *J. Asiatic Soc. Bengal*, XXXVIII, (ii), 1869, p. 162.

Cyclostrematidae.

- Cyclostrema eburneum* Nevill. *Cyclostrema eburnea* Nevill, *J. Asiatic Soc. Bengal*, XLIV (ii), 1875, p. 101.
- Cyclostrema bushi* Dautzenberg & Fisher, *J. Conchyl.*, LIV, 1906, p. 207.

Turbinidae.

- Turbo brunneus* (Röding = *intercostalis*, auct. non Menke). *T. articulatus* Reeve IV, ix, 39.
- Turbo marmoratus* Linnaeus. Reeve IV, i, 2.
- Phasianella (Tricolia) indica*. Winckworth. *Proc. Malac. Soc.* XXIV, 1940, p. 41, fig. 1.

Neritidae.

- Nerita albicilla* Linnaeus. Schepman, p. 3.
- Nerita chameleon* Linnaeus. Schepman, p. 4.
- Neritina (Smaragdia) oualaniensis* Lesson. Reeve IX, xxxvi, 168.
- Neritina crepidularia* Lamarck. Reeve IX, viii, 38.
- Neritina siquijorensis* Reeve IX, xxvii, 119.
- * *Neritina aciculata* Reeve IX, xxiv, 108.

Littorinidae.

- Littorina undulata* Gray. Schepman, p. 194.
- Littorina scabra* (Linnaeus). Schepman, p. 193.
- Littorina subgranosa* (Dunker). *Melarthaphe subgranosa* Dunker, *Verhandl. K. K. Zool.-Bot. Ges.* XVI, 1886, p. 913. Frauenfeld, *Reis. Ost. Freg. Novara, Zool. Moll.* (3) II (1867), p. 9, pl. i, figs. 10.
- Littorina subgranosa* var. *eudeli* Sowerby. *Littorina eudeli* Sowerby, *Ann. Mag. Nat. Hist.* (8) XVI, 1915, p. 167, pl. x, fig. 5.
- Littorina subgranosa* var. *novae-zealandiae* (Reeve). *Littorina novaezealandiae* Reeve X, xiv, 74.
- Littorina melanostoma*. Reeve X, ix, 45.
- Tectarius (Nodilittorina) malaccanus* (Philippi). *Littorina malaccana* Reeve X, ii, 7.

Rissoidae.

- Cingula oscitans* (Preston). *Rissoina oscitans* Preston, *Journ. Malac. Soc.* XII, p. 5.
- Rissoina clathrata* A. Adams. Reeve XX, ix, 76.
- Rissoina rissoi* (Audouin). *Rissoa rissoi* Audouin, *Esplic. des. pl. de Savigny Deser. de l'Egypte, Coquilles* (1826), pl. iv, fig. 1; reproduced in Pallary, *Mém. Inst. Egypte* XI, p. 65, pl. viii, fig. 1.

Assimineidae.

- Assiminea rubella* Blanford, *J. Asiatic Soc. Bengal* XXXVI (ii), 1867, p. 55.
Assiminea brevicula (Pfeiffer). Nevill, *J. Asiatic Soc. Bengal* L (1), 1881, p. 159, pl. vii, fig. 6.
*Assiminea woodmasoniana*¹ Nevill, *J. Asiatic Soc. Bengal* XLIX (ii), 1880, p. 163.
*Assiminea hungerfordiana*¹ Nevill, *J. Asiatic Soc. Bengal* XLIX (ii), 1880, p. 165.

Turritellidae.

- Turritella acutangula* (Linnaeus). *Turritella duplicata* Reeve V, i, 2.
Turritella attenuata Reeve V, i, 4.
Turritella columnaris Kiener. Reeve V, iv, 14.

Architectonidae.

- Architectonica laevigata* (Lamarck). *Solarium laevigatum* Reeve XV, ii, 9.
Architectonica purpurata (Hinds). *Solarium Purpuratum* Reeve XV, i, 5.
Architectonica perspectiva (Lamarck). *Solarium perspectivum* Reeve XV, ii, 11.
Architectonica aspera (Hinds). *Solarium asperum* Hinds, *Proc. Zool. Soc. London*, 1844, p. 23; Sowerby, *Thesaurus* III (1863), pl. ccliv, figs. 77-78.
Heliacus stramineus (Gmelin). *Solarium stramineum* Sowerby, *Thesaurus* III, pl. ccliv, figs. 95-97.
Heliacus dorsuosus (Hinds). *Solarium dorsuosum* Hinds, *Proc. Zool. Soc. London* XII, 1844, p. 23; Sowerby, *Thesaurus* III, pl. ccliv, figs. 73-74.

- * *Torinia costata* Schepman, p. 221, pl. xiv, fig. 5.

Vermetidae.

- * *Siliquaria tosta* Mörch. *Siliquaria tostus* Reeve XX, iv, 11.
Siphonium sp.

Planaxidae.

- Planaxis sulcatus* (Born). Schepman, p. 171.
Planaxis similis Smith. Reeve XX, ii, 11.

Potamididae.

- Cerithidea fluviatilis* (Potiez and Michaud; = *cingulatus* Gmelin). *Potamides (Tympanotonos) fluviatilis* Schepman, p. 168.
Cerithidea obtusum Lamarck. *Cerithium obtusum* Adams, *Zoology of the "Samarang"*, Mollusca (London 1848), p. 43, pl. xiii, fig. 3.
Terebralia palustris (Linnaeus). *Potamides (Terebralia) palustris* Schepman, p. 168.
Telescopium telescopium (Linnaeus). *Telescopium fuscum*. Reeve XV, i, 1.

Finellidae.

- Finella virgata* (Philippi). Nevill, *Handlist of Mollusca, Indian Museum*, II (Calcutta 1884), p. 115.

Cerithiidae.

- Cerithium granosum* Kiener. Schepman, p. 160.
Cerithium kochi Philippi. Watson, *Challenger Exped. Rep.* XV (1873-1876), Gastropoda, p. 537.
* *Cerithium gemma* Sowerby. Reeve XV, x, 70.
Cerithium crichtoni, *nom. nov.* for *C. lineatum* Duncker Ms., *non* Lamarck Tryon. *Man. Conch.* VIII, (1886) p. 143, pl. xxvii, figs. 27-28.

Triphoridae.

- ? *Triphora* and *Ino* spp.

Epitoniidae (= Scalidae).²

- Epitonium scalaris* (Linnaeus). *Scalaria pretiosa* Reeve XIX, i, 4.
Epitonium pyramidalis (Sowerby). *Scalaria pyramidalis* Reeve XIX, iii, 17.

¹ Fresh water species.

² See also above, p. 28, footnote 1.

Epitonidae—cont.

Epitonium philippinarum (Sowerby). *Scalaria philippinarum* Reeve XIX, iv, 21.

Epitonium subtile (Sowerby). *Scalaria subtilis* Reeve XIX, xiv, 105.

Acrilla acuminata (Sowerby). *Scalaria acuminata* Reeve XIX, x, 74.

Opalia (*Dentiscala*) *sp.*

Eglisia tricarinata Adams and Reeve, *Zoology of the "Samarang"*, Mollusca (London 1848), p. 49, pl. xii, fig. 8.

Janthinidae.

* *Recluzia jehennei* Petit, *J. Conchyl.* IV, 1853, p. 118, pl. v, fig. 3.

Janthina roseola Reeve. *Janthina roseola* + *affinis* Reeve XI, i, 1 and 2.

Janthina globosa Swainson. *Janthina globosa* Swainson, Reeve XI, iv, 18.

Eulimidae.

Eulima bivittata (H. and A. Adams). *Leiostraca bivittata*. Reeve XV, i, 6.

Eulima attenuata Sowerby Schepman, p. 235.

Eulima martinii A. Adams. Schepman, p. 234.

* *Eulima oblonga* Boettger, *Nachrbl. dtsh. Malakozool. Ges.* XXV, 1893, pp. 162-163.

Eulima acufornis G. & H. Nevill. *J. Asiatic Soc. Bengal* XLIV (ii), 1875, p. 98.

Niso pyramidelloides G. & H. Nevill. *J. Asiatic Soc. Bengal* XL (ii), 1871, p. 5.

Niso sumatrana Thiele, *Dtsch. Tiefsee-Exp.* XVII (2), 1925, p. 308, pl. xxiv, figs. 8-10.

Stiliferidae.

Stilifer sibogae Schepman, p. 241.

* *Apicalia* *sp.*

Pyramidellidae.

Chrysallida epentromidea (Melvill). *Pyrgulina epentromidea* Melvill, *Ann. Mag. Nat. Hist.* (7) IV, 1899, p. 94.

Chrysallida germaini (Deutzenberg and Fischer). *Pyrgulina germaini* D. & F., *J. Conchyl.* LIV, 1906, p. 193.

Chrysallida sykesi (Deutzenberg & Fischer). *Pyrgulina sykesi* D. & F., *Journ. Conchyl.* LIV, 1906, p. 187.

Chrysallida humilis (Preston). *Pyrgulina humilis* Annandale & Kemp, *Mem. Ind. Mus.* V, 1916, p. 347.

Kleinella diana (A. Adams). *Tornatella diana* Reeve XV, iv, 19.

Kleinella punctigera (A. Adams). *Parthenia punctigera* A. Adams, *Ann. Mag. Nat. Hist.* (3) VI, 1860, p. 415.

Kleinella sundaica (Thiele). *Leucotina (Adelactaeon) sundaica* Thiele, *Dtsch. Tiefsee-Exp.* XVII (2), 1925, p. 326.

Kleinella ceylanica (Preston). *Pyramidella (Actaeopyramis) ceylanica* Preston, *Journ. Malac.* XII, 1905, p. 7.

Kleinella fulva (A. Adams). *Monopygma fulva* A. Adams, *Proc. Zool. Soc. London* XIX, 1851, p. 222.

Kleinella casta (A. Adams). *Odostomia (Parthenia) casta* Watson, *Challenger Exped. Rep.* XV, 1873-1876, p. 487.

Odostomia babylonica Winckworth, *Proc. Malac. Soc.* XXIV, 1940; pp. 41-42, fig. 2.

Odostomia compta Brazier. *Odostomia eutropia* Melvill *Ann. Mag. Nat. Hist.* (7) IV, 1899, p. 94.

Odostomia dubiosa (G. & H. Nevill). *Syrnola dubiosa* G. & H. Nevill, *J. Asiatic Soc. Bengal* XL (ii), 1871, p. 5.

Odostomia attenuata (A. Adams). *Pyramidella attenuata* Reeve, XV, iv, 28.

* *Odostomia brunnea* (A. Adams). *Pyramidella brunnea* Reeve XV, i, 1.

Cingulina superba Thiele, *Dtsch. Tiefsee-Exp.* XVII (2), 1925, p. 326.

Cingulina trisulcata Sowerby, *Proc. Malac. Soc.* I, 1895, p. 157.

Turbonilla crichtoni Winckworth, *Proc. Malac. Soc.* XXIV, 1940, p. 42, fig. 3.

Turbonilla coromandelica Melvill & Standen, "Marine Mollusca of Madras", *Journ. Conch.* IX (i), 1898, p. 32.

Pyramidellidae—cont.

- Turbonilla templaris* Melvill, *Proc. Malac. Soc.* IX, 1910, p. 191.
Turbonilla augusta Thiele, *Dtsch. Tiefsee-Exp.* XVII (2), 1925, p. 320.
Pyramidella turrita (A. Adams). Schepman, p. 242.
Pyramidella teres (A. Adams). Reeve, XV, i, 6.
Pyramidella pulchella (A. Adams). Reeve, XV, iv, 24.
Pyramidella terebellum (Müller). Reeve, XV, ii, 14.

Fossaridae.

- Couthouyia insignis* (Nevill). *Fossarus insignis* Nevill, *J. Asiatic Soc. Bengal*, XL (ii), 1871, p. 4.
Fossarus tornatilis Gould. Nevill, *Handlist of Mollusca Indian Museum II* (Calcutta, 1884), p. 163.

Hipponycidae.

- Hipponyx tricarinata* (Linnaeus). *Capulus (Amathina) tricarinatus* Watson, *Challenger Exped. Rep.* XV, 1873-1876, p. 456.

Calyptraeidae.

- Calyptraea (Crucibulum) extintorium*¹ Lamarck. Reeve XI, v, 14.
Crepidula walshi Hermannsen. Schepman, p. 201.

Xenophoridae.

- Xenophora indica* (Gmelin). Schepman, p. 205.
Xenophora solaris (Linnaeus). Schepman, p. 205.
Xenophora corrugata (Reeve). Schepman, p. 203.

Strombidae.²

- Rimella cancellata* (Lamarck). Schepman, p. 155.
Strombus succintus Linnaeus. Schepman, p. 150.

Naticidae.

- Natica marochiensis* (Gmelin). Schepman, p. 208.
Natica albula (Röding; = *rufa* Born of Reeve IX, xvi, 70; *non albula*, Reeve IX, vi, 23). Schepman, p. 211.
Natica ala-papilionis Chemnitz. Reeve IX, xiv, 60.
Natica tigrina (Röding; = *maculosa* Lamarck). Reeve IX, xiii, 57.
Natica traillii Reeve IX, xxix, 137.
Natica pulicaris Philippi. Reeve IX, xv, 63.
Natica raynoldiana Récluz. *N. raynaudiana*, Reeve IX, xiii, 56.
Natica picta Récluz. Reeve IX, xv, 67.
Natica lineata Lamarck. Schepman, p. 211.
Natica lamarchii Chenu. *N. lamarchiana* Reeve IX, ii, 6.
Natica didyma (Röding). *N. chemnitzii* Reeve IX, v, 17.
Albula (incl. Polinices) mamilla (Linnaeus). *Natica (Mamma) mamilla* Schepman, p. 215.
Albula pes-elephantae Link. *Natica columnaris*, Reeve IX, v, 19.
Albula melanostoma (Gmelin). *Natica (Mamilla) melanostoma*, Schepman, p. 216.
Albula melanostomoides (Quoy & Gaimard). *Natica (Mamilla) melanostomoides*, Schepman, p. 216.
Eunaticina pomatiella (Melvill). *Naticina pomatiella* Melvill, *J. Bombay Nat. Hist. Soc.* VIII, 1893, p. 241.

¹ Mr. Winchworth informs me that this name may have to be changed to *C. renovatum* Crosse & Fischer (*J. Conchyl.* XXXVII, 1889, p. 37) as these authors are probably right in their belief that Lamarck's type is distinct from the species called *C. extintorium* by Reeve and others. But he has not been able to look fully into the matter so the better known name is retained here provisionally.

² See also above, p. 35, footnote 2.

Naticidae—cont.

- Eunaticina coarctata* (Reeve). *Sigaretus coarctatus* Reeve, XV, iv, 17.
Eunaticina papilla (Gmelin). *Sigaretus (Eunaticina) papilla* Dautzenberg & Fischer, *Journ. Conchyl.* LIV, 1906, p. 176.
Sinum neritoideum (Linnaeus). *Sigaretus neritoideus* Reeve XV, i, 5; ? *S. javanicus* Reeve XV, ii, 8.
Sinum cuvierianum (Récluz). *Sigaretus cuvierianus* Reeve XV, iii, 12.
Sinum delessertii (Récluz). *Sigaretus delessertii* Reeve XV, ii, 10.
Sinum halotoideum (Linnaeus). *Sigaretus incisus (non halotoideus)* Reeve XV, iii, 11.
Sinum planulatum (Récluz). *Sigaretus planulatus* Reeve XV, ii, 7.

Cypraeidae.

In Drs. F. A. & M. Schilder's recent "Monograph on Living Cypraeidae" (*Proc. Malac. Soc.* XXIII, 4, March 1939, pp. 119-231) the genus *Cypraea* as defined above is split up into a number of genera and subgenera. The position of the Madras species (and others mentioned in connection with them) in their system of classification is indicated below in the references given to their paper, to which all references under the name Schilder relate.

? *Erato* sp.

Volva sowerbyana (Weinkauff) Schilder, *Proc. Malacol. Soc. London*, XX, 5, p. 73.

- * *Cypraea caput-serpentis* Linnaeus. Reeve III, xi, 44. *Erosaria (Ravitronea) caputserpentis* Schilder, p. 135.
Cypraea erosa Linnaeus. Schepman, p. 134. *Erosaria (s. str.) erosa* Schilder, p. 137.
Cypraea ocellata Linnaeus. Reeve III, xv, 73. *Erosaria (s. str.) ocellata* Schilder, p. 138.
Cypraea lamarkii Gray. Reeve III, x, 37. *Erosaria (s. str.) lamarkii* Schilder, p. 139.
Cypraea moneta Linnaeus. Schepman, p. 129. *Monetaria (s. str.) moneta* Schilder, p. 142.
Cypraea pallida Gray. Reeve III, xiii, 54. *Erronea (Adusta) pallida* Schilder, p. 148.
Cypraea onyx Linnaeus. Reeve III, x, 39. *Erronea (Adusta) onyx* Schilder, pp. 149-150.
Cypraea caurica Linnaeus. Schepman, p. 128. *Erronea (s. str.) caurica* Schilder, pp. 153-154.
Cypraea fimbriata Gmelin. Schepman, p. 127. *Palmadusta (Melicerona) fimbriata* Schilder, pp. 162-163.
Cypraea cribraria Linnaeus. Schepman, p. 134. *Cribraria (s. str.) cribraria* Schilder, pp. 171-172.
Cypraea nivosa Broderip. Reeve III, vii, 25. *Callistocypraea (s. str.) nivosa* Schilder, p. 177.
Cypraea arabica Linnaeus. Schepman, p. 129. *Mauritia (Arabica) arabica* Schilder, p. 186.
Cypraea arabica var. *histrion* Gmelin. *Cypraea reticulata* Reeve III, i, 3. *Mauritia (Arabica) histrion* Schilder, pp. 183-184.
* *Cypraea tigris* Linnaeus. Reeve III, iv, 12. *Cypraea (s. str.) tigris* Schilder, p. 185.

Cassididae.

- Phalium bisulcatum* (Schubert and Wagner). *Cassis bisulcata* Schepman, p. 122.
Phalium canaliculatum (Bruguère). *Cassis canaliculata* Reeve V, iii, 8.
Phalium areola (Linnaeus). *Cassis areola* Reeve V, ix, 24.
Phalium glaucum (Linnaeus). *Cassis glauca* Schepman, p. 122.

Cymatiidae (= Tritonidae).

- Gyrineum natator* (Röding). *Ranella tuberculata* Reeve II, vii, 36.
Cymatium retusum (Lamarck). *Triton retusum* Reeve II, xii, 47.
Cymatium cingulatum (Lamarck). *Triton cingulatus* Reeve II, xi, 35.
Cymatium pileare (Linnaeus). *Aquillus (Lampusia) pilearis* Schepman, p. 110.
Cymatium rhinoceros (Röding; = *Iotrium* Lamarck and Reeve non Linnaeus). Reeve II, vi, 19.
Cymatium chlorostomum (Lamarck). *Triton chlorostoma* Reeve II, vii, 25.
Cymatium caudatum (Gmelin; = *canaliferum* Lamarck). *Triton canaliferus* Reeve II, iii, 8.
Cymatium labiosum (Wood). *Triton labiosus* Reeve II, xiv, 52.
Distorsio cancellina (Lamarck). *Distortix cancellinus*, Schepman, p. 113.

Bursidae¹.

Bursa rubeta (Linnaeus). *B. (Bufonia) lampas*, Schepman, p. 118.

Bursa granularis (Röding). *Ranella granifera* Reeve II, vi, 30.

Bursa margaritula (Deshayes). Schepman, p. 116.

Bursa crumena (Lamarck). Schepman, p. 117.

Bursa rana (Linnaeus). *Ranella albivaricosa* Reeve II, i, 2.

Bursa spinosa (Lamarck). *Ranella spinosa*, Reeve II, ii, 7.

Bursa suensonii Mörch, *Cat. Yoldi* (1852), p. 106.

Tonnidae (= Doliidae).

Tonna dolium (Linnaeus). *Dolium maculatum*, Reeve V, iii, 4.

Tonna cumingii (Reeve). *Dolium cumingii* Reeve, V, viii, 13.

Tonna fasciata (Lamarck). *Dolium fasciatum*, Schepman, p. 125.

Tonna pomum (Linnaeus). *Dolium (Malea) pomum*, Schepman, p. 125.

Ficidae (= Pirulidae).

Ficus ficus (Linnaeus). *Ficula laevigata*, Reeve (non Lamarck), IV, i, 4.

Ficus ficoides (Lamarck). *Ficula reticulata* Reeve IV, i, 1.

Ficus gracilis (Sowerby; = *dussumieri* Reeve). *Pirula gracilis*, Schepman, p. 126.

Muricidae.

*Rapana bulbosa*¹ (Dillwyn). *Pyrula bulbosa*, Reeve IV, iv, 14.

Murex secundus Lamarck. Reeve III, xxiv, 97.

Murex incarnatus (Röding). *Murex ramosus* Reeve (non Linnaeus), III, i, 3.

Murex torrefactus Sowerby. Reeve III, x, 41.

Murex adustus Lamarck. Schepman, p. 346.

Murex virgineus (Röding; = *anguliferus* Lamarck). *Murex anguliferus*, Reeve III, xi, 43.

Murex virgineus var. *ponderosa* Sowerby. *Murex ponderosus* Sowerby, *Thesaurus* IV, 1879, pl. ccclxxxvii fig. 67.

Murex pinnatus, Wood. Reeve III, xiv, 57.

Murex tribulus Linnaeus. *Murex ternispina* (non *tribulus* Reeve III, xx, 82), Reeve III, xviii 73, xix 76.

Murex tribulus var. *trapa* Röding. *Murex martinianus* Reeve III, xviii, 72.

Murex haustellum Linnaeus. Schepman, p. 344.

* *Murex erinaceus* Linnaeus. Reeve III, iii, 2.

Thais margaritica (Broderip). *Ricinula fuscillum* Reeve III, iv, 28.

Thais margaritica var. *heptagonalis* (Reeve). *Ricinula heptagonalis* Reeve III, iii, 17.

Thais granulata (Duclos). *Ricinula tuberculata*, Reeve III, ii, 11.

Thais anaxares (Duclos). *Sistrum (Morula) anaxares* Schepman, p. 355.

Thais subnodulosa (Melvill). *Ricinula (Sistrum) subnodulosa* Melvill, *J. Bombay Nat. Hist. Soc.* VIII, 1893 p. 235.

Thais bimucronata (Cumming). *Buccinum bimucronatum* Reeve III, xi, 88.

Thais kochiana (Sowerby). *Ocenebra kochiana* Sowerby, *Proc. Malac. Soc.* IV, 1900, p. 126, pl. xi, fig. 1.

Thais tissoti (Petit). *Journ. Conchyl.* III, 1852, p. 163.

Thais sp. nr. *tissoti*

Thais rugosa (Born; = *sacellum* Gmelin). *Purpura sacellum*, Reeve III, xi, 58.

Thais gemmulata (Lamarck). *Purpura mancinella*, Reeve III, i, 2.

Thais intermedia (Kiener). *Purpura intermedia*, Reeve III, viii, 38.

¹ See also p. 45, footnote.

² Mr. Winckworth informs me that *R. bulbosa* (Dillwyn, 1817) is a synonym of *R. rapiformis* (Born 1778), but that the latter is a less fortunate name as it includes a form B which is not this species but *R. bezoar*. The name *bulbosa* has therefore been retained here, especially as it is the one in general use.

Muricidae—cont.

Thais carinifera (Lamarck). *Cuma carinifera*, Schepman, p. 354.

Thais bufo (Lamarck). *Purpura bufo*, Reeve III, ii, 7.

Thais bufo var. *callosa* (Lamarck). *Purpura bufo* var. B, Reeve III, ii, 7.

Thais rudolphi (Lamarck). *Purpura rudolphi*, Reeve III, ii, 10.

Pyrenidae = Columbelloidae.

Pyrene flavilinea (Melvill). *Columbella* (*Mitrella*) *flavilinea* Melvill, *J. Bombay Nat. Hist. Soc.* VIII, 1893, p. 237.

Pyrene puella (Sowerby). *Columbella puella*, Reeve XI, xiii, 65.

Pyrene vulpecula (Sowerby). *Columbella vulpecula*, Reeve XI, xvi, 80.

Pyrene terpsichore (Sowerby). *Columbella terpsichore*, Reeve XI, xii, 58 b.

Pyrene townsendi (Melvill and Standen). *Columbella townsendi* Melvill and Standen, *Proc. Zool. Soc. London*, 1901, p. 408, pl. xxiii, fig. 8.

Pyrene japonica (Gould). *Aesopus japonicus* Gould, *Proc. Boston Soc. Nat. Hist.* VII, 1860, p. 383.

Pyrene thyraea (Melvill). *Terebra thyraea* Melvill, *Mem. Proc. Manchester Lit. Phil. Soc.* XLI (7), p. 10, pl. vi, fig. 13.

Buccinidae.

Babylonia (= *Eburna*) *spirata* (Linnaeus). *Eburna spirata*, Reeve V, i, 7.

Babylonia zeylanica (Lamarck). *Eburna zeylanica*, Reeve V, i, 8.

Engina zea Melvill. *J. Bombay Nat. Hist. Soc.* VIII, 1893, p. 236.

Engina sp.

Cantharus (*Polia*) *undosus* (Linnaeus). *Tritonidea undosa* Schepman, p. 302.

Cantharus (*Polia*) *proteus* (Reeve). *Buccinum proteus* Reeve III, vii, 51.

Cantharus (s. str.) *spiralis* (Gray). *Buccinum spirale* Reeve III, iii, B.

Cantharus (s. str.) *melanostoma* (Reeve). *Buccinum melanostoma* Reeve III, iii, 1.

Cantharus (s. str.) *tranquebaricus* (Gmelin). *Buccinum tranquebaricum* Reeve III, iii, 17.

Nassaria nivea (Gmelin). *Nassaria nivea*, Schepman, p. 310.

Nassaria suturalis (A. Adams). *Nassaria suturalis* Schepman, p. 310.

Volemidæ (= Galeodidae).

Hemifusus pugilinus (Born). *Pyrula pugilina* Reeve IV, i, 1.

Nassidae.

Cyllene fuscata A. Adams, *Proc. zool. Soc. London* XVIII, 1850 (1851), p. 205; Sowerby, *Thesaurus* III, pl. ccxvii, figs. 10-11.

Bullia tranquebarica (Röding). *B. belangeri* Reeve III, ii, 8.

Bullia livida Reeve III, ii, 10.

Bullia vittata (Linnaeus). Reeve III, ii, 9.

Nassa lentiginosa A. Adams. Reeve VIII, iii, 15.

Nassa olivacea (Bruguière). *Nassa* (*Zeuxis*) *taenia* Schepman, p. 319.

Nassa elegans Kiener. *Nassa* (*Alectryon*) *elegans* Schepman, p. 313.

Nassa ceylonica G. & H. Nevill. *N. obesa* var. *ceylonica* G. & H. Nevill, *J. Asiatic Soc., Bengal* XLIV (ii), 1875, p. 96.

Nassa dorsata (Röding). *Nassa* (*Zeuxis*) *canaliculata* Schepman, p. 319.

Nassa sp. nr. *dorsata*.

Nassa planocostata A. Adams. Reeve VIII, xii, 76.

Nassa bellula A. Adams. Reeve VIII, xxviii, 184.

Nassa jacksoniana (Quoy & Gaimard), *Proc. Zool. Soc. London*, XIX, 1851, p. 103.

Nassa stolata Gmelin. *N. ornata* Reeve VIII, v, 33.

Nassa pulla (Linnaeus). Reeve VIII, iv, 22.

Nassidae—cont.

Nassa hepatica (Montagu). *Nassa monile* + *lachrymosa* Reeve VIII, vi, 38 and viii, 52.

Nassa costata A. Adams. Reeve VIII, xxi, 142.

Nassa sumatrana Thiele, *Dtsch. Tiefsee-Exped.* XVII (2) 1925, p. 330, pl. xxxii, fig. 15.

Nassa mangelioides Reeve VIII, xxiii, 152.

Nassa sp. nr. *mangelioides*.

Nassa globosa (Quoy & Gaimard). *Nassa* (*Arcularia*) *globosa* Schepman, p. 313.

Nassa gemmulifera A. Adams. Reeve VIII, xx, 132.

Nassa sp. nr. *gemmulifera*.

Nassa variegata A. Adams. *Nassa* (*Niotha*) *gemmulata* var. *variegata*, Schepman, p. 328.

Pygmaeonassa denegabilis (Preston). *Nassa denegabilis* Preston, *Rec. Ind. Mus.*, X, 1914, pp. 297-299.

Fasciolaridae.

Fusinus longicauda (Bory). Reeve IV, iii, 13 (fig. not good).

* *Fusinus colus* Linnaeus. Schepman, p. 290.

Fusinus toreuma Lamarck. *Fusus toreuma*. Reeve IV, vii, 27.

Peristernia pulchella (Reeve). Schepman, p. 298.

Peristernia spp.

Olividae.

Ancilla ampla (Gmelin). Schepman, p. 256.

Ancilla cinnamomea (Lamarck). *Ancillaria cinnamomea* Reeve XV, vii, 19.

Oliva gibbosa (Born). Reeve VI, viii, 12.

Oliva nebulosa Lamarck. Reeve VI, xvi, 32.

Oliva ispidula (Linnaeus). Schepman, p. 254.

Oliva oliva (Linnaeus). *Oliva maura* Schepman, p. 251.

Oliva lepida Duclos. Schepman, p. 254.

Mitridae.

Mitra robusta Reeve. Reeve II, xviii, 140.

Mitra cucumerina Lamarck. *Mitra* (*Chrysame*) *cucumerina*, Schepman, p. 275.

Mitra lacunosa. Reeve. Reeve II, x, 65.

Mitra proscissa Reeve. Reeve II, xxii, 177.

Mitra caeligena Reeve. Reeve II, xxviii, 227.

Mitra marginata Sowerby. *Mitra Schroeteri*, Reeve II, xxi, 167.

Mitra insculpta A. Adams, *Proc. Zool. Soc., London*, XIX 1851, p. 133.

Mitra circula Kiener. *Mitra circulata* Reeve II, xi, 77.

Mitra granatina Lamarck. *Mitra scabriuscula* (non Linnaeus) Reeve II, V, 35.

Mitra pellis-serpentis Reeve s. str. *Mitra* (*Nebularia*) *pellis serpentis* Schepman, p. 271.

Mitra pellis-serpentis var. *granata* Reeve. *Mitra* (*Chrysame*) *granata*, Schepman, p. 276.

Mitra mica Reeve II, xxxvii, 314.

Mitra acuminata (Gmelin non Sowerby). *Mitra crebrilirata*, Reeve II, xiii, 92.

Vasidae (= Turbinellidae).

Xancus pyrum (Linnaeus; = *napus* Lamarck). *Xancus pyrum pyrum*. Winckworth. *Proc. Malac. Soc.* XXIII (6), 1939, p. 347.

Xancus dentatus (Burrow; = *pyrum* Lamarck) *Turbinella pyrum*. Reeve IV, iii, 15.

* *Xancus rapa* (Lamarck). *Turbinella rapa* Reeve IV, ii, 8.

Tudicla spirillus (Linnaeus). *Pyrula spirillus* Reeve IV, ix, 29.

Harpidae.

Harpa conoidalis Lamarck. Reeve I, iii, 7.

Volutidae.

Cymbium melo (Solander). *Cymbium indicum*. Reeve, XIII, xvii, 9.

Cancellariidae.

Cancellaria exquisita Preston, *Journ. Malac.* XII, 1905, p. 3.

Cancellaria oblonga Sowerby. Reeve X, vi, 27.

Cancellaria elegans Sowerby. Reeve X, iii, 12.

Cancellaria tenuis Adams. Reeve X, xvi, 75.

Cancellaria articularis Sowerby. Reeve X, xii, 54.

Cancellaria crispa Sowerby, s. str. *Cancellaria crispata* Reeve X, ix, 43.

Cancellaria crispa var. *costifera* Sowerby. *Cancellaria crenifera* Reeve X, vi, 24.

Cancellaria crispa var. *lamellosa* Hinds. *Cancellaria lamellosa* Reeve X, xiv, 65.

Cancellaria crispa var. *hystrix* Reeve. *Cancellaria hystrix* Reeve, X, xiv, 67.

Marginellidae.

Marginella angustata Sowerby. Reeve XV, xiii, 55.

Marginella ventricosa Fischer. *Marginella quinqueplicata* Reeve XV, x, 40.

Marginella mazagonica Melvill, *Bombay Nat. Hist. Soc.* VIII (1893), p. 238.

Marginella dens Reeve. Reeve XV, xxii, 120.

Turridae (= Pleurotomidae).

Asthenotoma coffea (Thiele). *Pleurotoma* (*Hemipleurotoma*) *coffea* Thiele, *Dtsch. Tiefsee-Exped.* XVII (2), 1925, p. 300, pl. xxxv, fig. 6.

Asthenotoma texta (Thiele). *Pleurotoma* (*Hemipleurotoma*) *texta* Thiele, loc. cit., pp. 300-301.

Asthenotoma vertebrata (Smith). *Pleurotoma* (*Hemipleurotoma*) *vertebrata*, Schepman, p. 401.

Turricula tornata (Dillwyn) = *javana* Reeve non Linnaeus). *Pleurotoma javana* Reeve I, iv, 26.

Turricula javana (Linnaeus non Reeve) *Pleurotoma nodifera*, Reeve I, iv, 28.

Turris indica Röding. *Pleurotoma marmorata* Reeve I, i, 3.

Turris variegata (Kiener). *Pleurotoma variegata* Reeve I, i, 2.

Turris sp. nr. *variegata*.

Turris acuta (Perry) = *tigrina* Reeve). *Pleurotoma tigrina*, Schepman, p. 399.

Turris nelliae (Smith). *Pleurotoma nelliae*, Smith, *Ann. Mag. Nat. Hist.* (4) XIX, 1877, p. 489; *Surcula nelliae* Melvill, *Proc. Malac. Soc.* XII, 1917, p. 164, pl. viii, fig. 2.

Turris ceylonica (Smith). *Pleurotoma ceylonica*, Smith, *Ann. Mag. Nat. Hist.* (4) XIX, 1877, p. 489.

Turris multiseriata (Smith). *Pleurotoma multiseriata* Smith, *Ann. Mag. Nat. Hist.* (4) XIX, 1877, p. 491; Melvill, *Proc. Malac. Soc.*, XII, 1917, p. 145, pl. viii, fig. 3.

Turris sp. nr. *multiseriata*.

Brachytoma tayloriana (Reeve). *Pleurotoma tayloriana* Reeve I, XL, 366.

Brachytoma barkliensis (H. Adams). *Drillia barkliensis* H. Adams, *Proc. Zool. Soc. London*, 1869, p. 272, pl. xix, fig. 3.

Brachytoma griffithi (Gray). *Pleurotoma griffithii* Reeve I, vii, 57.

Brachytoma enna (Dall). *Nom. nov.* (1918) for *Pleurotoma unifasciata* Smith 1888, non Deshayes 1833; *Pleurotoma* (*Drillia*) *unifasciata* Smith, *Ann. Mag. Nat. Hist.* (6) II, 1888, p. 300.

Brachytoma incerta (Smith). *Pleurotoma* (*Drillia*) *incerta* Smith, *Ann. Mag. Nat. Hist.* (4) XIX, 1877, p. 496; *Drillia incerta* Melvill, *Proc. Malac. Soc.*, XII, 1917, p. 153, pl. viii, fig. 5.

Brachytoma major (Reeve). *Pleurotoma major* Reeve I, vii, 59.

Brachytoma crenularis (Lamarck). *Pleurotoma crenularis*, Reeve I, vii, 54.

Brachytoma flavidula (Lamarck). *Pleurotoma flavidula*, Reeve I, viii, 66.

Brachytoma intertincta (Smith). *Pleurotoma* (*Drillia*) *intertincta* Smith, *Ann. Mag. Nat. Hist.* (4) XIX, 1877, p. 497; *Drillia intertincta* Melvill, *Proc., Malac. Soc.* XII, 1917, p. 154, pl. viii, fig. 6.

Turridae (= Pleurotomidae)—cont.

- Lienardia obtusicastrata* (Smith). *Pleurotoma* (*Glyphostoma*) *obtusicastrata* Smith, *Ann. Mag. Nat. Hist.* (5) X, 1882, p. 304; *Mangilia* (*Glyphostoma*) *obtusicastrata* Melvill & Standen, *Proc. Zool. Soc. London* II, 1901, p. 444, pl. XXI, fig. 4.
- Lienardia spurca* (Hinds). *Pleurotoma spurca*, Reeve I, xxxiv, 312.
- Lienardia gravellyi* Winckworth *Proc. Malac. Soc.* XXIV, 1940, p. 43.
- Lienardia cosmia* Winckworth, *Proc. Malac. Soc.* XXIV, 1940, p. 42.
- Lienardia* spp.
- Clavus persicus* (Smith). *Pleurotoma* (*Drillia*) *persica* Smith, *Ann. Mag. Nat. Hist.* (6), II, 1888, p. 307; *Drillia persica* Melvill, *Proc. Malac. Soc.* XII, 1917, p. 156, pl. ix, fig. 6.
- Clavus inconstans* (Smith). *Pleurotoma inconstans* Smith, *Ann. Mag. Nat. Hist.* (4) XV, 1875, p. 417; *Drillia inconstans* Melvill, *Proc. Malac. Soc.* XII, 1917, p. 153, pl. x, fig. 1.
- Clavus* sp. nr. *inconstans*.
- Pseudodaphnella lucida* (Smith). *Pleurotoma* (*Clathrella*) *lucida* Smith *Ann. Mag. Nat. Hist.* (5), XIV, 1884, p. 323; *Mangilia lucida* Melvill, *Proc. Malac. Soc.* X, 1912, p. 251, pl. xi, fig. 3.
- Pseudodaphnella* spp.
- Daphnella* spp.
- Haedroleura pellyi* (Smith). *Pleurotoma* (*Mangilia*) *pellyi* Smith *Ann. Mag. Nat. Hist.* (5), X, 1882, p. 218; Melvill, *Proc. Malac. Soc.* XII, 1917, p. 174, pl. ix, fig. 9; *Haedroleura lacta* Thiele, *Dtsch. Tiefsee-Exped.* XVII (2), 1925, p. 341, pl. pl. xxxvii, fig. 24.
- Cythara recta* (Smith). *Pleurotoma* (*Mangilia* ?) *recta* Smith, *Ann. Mag. Nat. Hist.* (6) II, 1888, p. 310; *Mangilia recta* Melvill, *Proc. Malac. Soc.* X, 1912, p. 251, pl. xi, fig. 3.
- Cythara lyrica* (Reeve). *Mangilia lyrica* Reeve III, iii, 20.
- Cythara capillacea* (Reeve). *Mangilia capillacea* Reeve III, ii, 10.
- Cythara vittata* (Hinds). *Mangilia vittata* Reeve III, vii, 53.
- Cythara nana* (Reeve). *Mangilia nana* Reeve III, viii, 71.
- * *Cythara stromboides* (Reeve). *Mangilia stromboides* Reeve III, v, 33.
- Cythara townsendi* (Sowerby). *Mangilia townsendi* Sowerby, *Proc. Malac. Soc.* I, 1895, p. 278, pl. xviii, figs. 1-2.
- Cythara cylindrica* (Reeve). *Mangilia cylindrica* Reeve III, ii, 9.

Conidae.

- Conus textile* Linnaeus. *Conus* (*Texti*) *textile*, Schepman, pp. 396-397.
- Conus amadis* Gmelin. Reeve I, xli, 222.
- Conus radiatus* Gmelin. *Conus* (*Magi*) *radiatus* Schepman, p. 389.
- Conus ceylanensis* Bruguière, *Encycl. Méth.*, Vers. 1, p. 636; Reeve I, xxxvii, 199.
- Conus figulinus* Linnaeus. *Conus* (*Figulini*) *figulinus* Schepman, p. 379.
- Conus betulinus* Linnaeus. Reeve I, xiii, 67.
- Conus monile* Bruguière, Reeve I, xii, 61.
- Conus voluminalis* Hinds. Reeve I, xxxvii, 206.

Terebridae.

- Hastula trailii* Deshayes. *Terebra trailii* Reeve XII, xxvi, 142.
- * *Hastula strigilata* (Linnaeus). *Terebra strigilata* Reeve XII, xviii, 85.
- Hastula strigilata* var. *elegans* (Küster). *Terebra elegans* Küster in Martini & Chemnitz, *Syst. Conch.-Cab.* ed. I, Volutacea (11), v. Abth. 2, 1839, pp. 31-32, pl. vi, fig. 13.
- Hastula tenera* (Hinds). *Terebra tenera* Reeve XII, xxviii, 148.
- Hastula longiscata* (Deshayes). *Terebra longiscata* Reeve XII, xxi, 103.
- Duplicaria* (= *Diplomeriza*) *concolor* (Smith). *Terebra concolor* Smith, *Ann. Mag. Nat. Hist.* (4), XI, 1873, p. 265.
- Duplicaria raphanula* (Lamarck). *Terebra raphanula* Reeve XII, xvii, 77.

Terebridae—cont.

- Duplicaria duplicata* (Linnaeus). *Terebra duplicata* Reeve XII, i, 3.
Terebra tantilla Smith, *Ann. Mag. Nat. Hist.* (4), XI, 1873, p. 270 & *Proc. Zool. Soc. London*, 1879, p. 185, pl. xix, fig. 4.
Terebra persica Smith, *Ann. Mag. Nat. Hist.*, XIX (iv), 1877, p. 225.
Terebra tricincta Smith, *Ann. Mag. Nat. Hist.* (4) XIX, 1877, p. 225.
Terebra textilis Hinds. *Terebra* (*Strioterebrum*) *textilis* Schepman, p. 368.
Terebra triseriata Gray. *Terebra* (*Strioterebrum*) *triseriata* Schepman, pp. 375-6.
Terebra anilis (Röding). *Terebra straminea* Reeve XII, xii, 47.
Terebra eximia Deshayes, Reeve XII, xxi, 106.
Terebra commaculata (Gmelin). *Terebra myuros* Schepman, pp. 367-8.

Acteonidae.

- Bullina bruguieri* A. Adams. Reeve XVIII, i, 3.
Acteon flammeus (Gmelin). Schepman, p. 462.
Acteon spp.
Pupa solidula (Linnaeus). Schepman, p. 460.
Pupa affinis (A. Adams). *Solidula affinis* Adams, *Proc. Zool. Soc. London*, XXII, 1854 (1855), p. 61; *Actaeon* (*Buccinulus*) *affinis* Watson, *Challenger Exped. Rep.*, XV, 1873-1876, p. 630, pl. xlvii, fig. 1.

Ringiculidae.

- Ringicula encarporens* Folin. Morelet, *Journ. Conchyl.*, XXVI, 1878, p. 161, pl. v, fig. 5.
Ringicula propinquans Hinds. Schepman, p. 475.

Hydatinidae.

- Hydatina velum* (Gmelin). *H. vexillum* Reeve XVI, ii, 4.

Bullidae.

- Bulla ampulla* Linnaeus. Schepman, p. 473.

Atyidae.

- Haminoea crocata* Pease. Reeve XVI, v, 29.
 * *Haminoea tenera* (Adams). Reeve XVI, i, 3.

Retusidae.

- Retusa pyramidata* (A. Adams). *Bulla* (*Cylichna*) *pyramidata* A. Adams in Sowerby, *Thesaurus* II, p. 595, pl. cxxv, fig. 149.
Volvula sp.

Scaphandridae.

- Acteocina townsendi* (Melvill). *Tornatina townsendi* Melvill, *Mem. Proc. Manchester Lit. Phil. Soc.*, XLII (4), 1898, p. 8, pl. i, fig. 20.
Acteocina involuta (Nevill). *Cylichna involuta* Nevill, *Asiatic Soc. Bengal*, XL (ii), 1871, p. 3.
Acteocina lactuca (Nevill). *Cylichna lactuca* Nevill, *Asiatic Soc. Bengal*, XL (ii), 1871, p. 2.
Cylichna protracta Gould, *Proc. Boston Nat. Hist. Soc.*, VII, 1859, p. 140.
 * *Cylichna cylindracea* (Pennant). Watson, *Challenger Exped. Rep.* XV, p. 663.
Cylichna sp.

Philinidae.

Philine orientalis Gray¹. *Philine aperta* Schepman, p. 476. *Philine* Hornell, "Common Molluscs of S. India", *Madras Fish. Bull.* XIV, 1921, p. 143, fig. 30.

Aplysiidae.

Aplysia fimbriata Adams & Reeve, *Zoology of the "Samarang"* (London, 1848), p. 63, pl. xvii, fig. 2.

Bursatella leachii Blainville. *Notarchus* Hornell, "Common Molluscs of South India" *Madras Fish. Bull.*, XIV, 1921, p. 145, fig. 32. *Bursatella leachii* Eales & Engel, "Monograph on Bursatella", *Proc. Malac. Soc.*, XXI, 1935, p. 296.

Cavoliniidae.

Cavolinia longirostris (Lesueur). Tesch, *Das Tierreich*, Lief. 36 Pteropoda, p. 36 (fig.), & *Siboga. Exp.*, Livr. XVI, Monogr. lii, (1904) p. 41.

Pleurobranchidae.

Euselenops luniceps (Cuvier). *Oscaniopsis luniceps* Bergh, *Siboga-Exp.*, Livr. XXV, Monogr. L (Leyden 1905), p. 50, pl. iii, fig. 1.

* *Pleurobranchaea brocki* Bergh. Farran "Opisthobranchiate Mollusca" in Herdman's *Rep. Ceylon Pearl Oyster Fish.* III (London, 1905), p. 355, pl. v, figs. 24-28.

Polyceratidae.

Kalinga ornata Alder and Hancock. Virabhadra Rao, *Rec. Ind. Mus.* XXXVIII, 1935, pp. 473-498, pl. xiv.

Dorididae.

Discodoris sp.

Arminidae.

Armina (*Armina* = *Pleurophyllidia*) *formosa* (Kelaart). *Pleurophyllidia formosa* Eliot, *Proc. Zool. Soc. London*, 1906, p. 679.

Armina (*Linguella*) *variolosa* Bergh. *Linguella variolosa* Eliot, *Proc. Zool. Soc., London*, 1906 (ii), pp. 681-682.

Scyllaeidae.

* *Scyllaea marmorata* Alder and Hancock, *Trans. Zool. Soc. London*, V, 1866, p. 136, pl. xxxiii, fig. 3.

* *Scyllaea viridis* Alder and Hancock, *Trans. Zool. Soc. London*, V, 1866, pp. 136-137, pl. xxxiii, figs. 4-5.

Aeolidiidae.

Glaucus marinus (Du Pont). *Glaucus fosteri* Alder and Hancock, *Trans. Zool. Soc. London*, V, 1863 (1866) p. 143, pl. xxxiii, fig. 13.

Ellobiidae.

Melampus sincaporensis Pfeiffer. Weber, *Zool. Ergeb. eine Reise in Niederl. Ost-Indien* IV (1897), p. 165, pl. viii, figs. 5, 23.

Melampus fasciatus (Deshayes). Schepman p. 458.

Melampus avenaceus Mousson, *J. Conchyl.* XVIII, 1870, p. 134.

Pythia plicata (Férussac). *Scarabus plicatus* Reeve XII, iii, 28.

Siphonariidae.

Siphonaria basseinensis Melvill, *Mem. Proc. Manchester Lit. Phil. Soc.*, VII, 1893, p. 63, pl. i, fig. 20; reprinted, *J. Bombay Nat. Hist. Soc.* VIII, 1893, p. 243, pl. i, fig. 2.

¹ Mr. Winckworth informs me that both this species from the Indian Ocean and the European *P. quadripartita* Ascanius (= *P. aperta*—non Linnaeus—Forbes and Hanley, *History of British Mollusca* III, 1851, pp. 530-541, pl. cxiv fig. 1 shell, pl. UU, fig. 1 animal; Brown, *Trans. R. Soc. Edinb.* LVIII, pp. 179-210) have commonly been confused with the Cape of Good Hope species *P. aperta* Linnaeus (*P. aperta* O'Donoghue, *Union of South Africa Fish. & Mar. Biol. Rep.* No. 7, 1929, pp. 7-9, pl. i, figs. 1-7). *P. orientalis* is readily distinguishable from the true *P. aperta* but is remarkably like *P. quadripartita* in shell and gizzard plates. In *P. orientalis* the head shield is, however, much shorter than the posterior lobe, whereas in *P. quadripartita* it is much larger.

INDEX.

Names of genera and species (whether accepted or mentioned as synonyms) are printed in Roman type, as are also names of families, orders, etc. All other terms, including technical terms defined in the text and popular names, are printed in italics.

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